32nd Annual Report

Vegetative Rehabilitation & Equipment Workshop

San Antonio, Texas
February 5-6 1978

The Vegetative Rehabilitation and Equipment Workshop is an organization of Federal and State agencies and private groups working to improve rangelands and further range equipment technology. Government officials and industry representatives from Canada and Mexico also participate.

To accomplish its goals, the Workshop evaluates and develops equipment and prescribes specifications and standards for equipment purchase, maintenance, and use. The Workshop also functions as a clearinghouse for the interchange of information and the dissemination of material describing its activities and accomplishments.

Those interested in participating in the Workshop should contact its chairman, Vern L. Thompson, Range Management Staff, USDA Forest Service, P.O. Box 2417, Washington, D.C. 20013

Cover: Five-component interseeder designed and built at the Forest Service San Dimas Equipment Development Center. The machine is designed to plant seed in rocky and brushy terrain.

August 1978

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Participants

U.S. Department of Agriculture

U.S. Department of the Interior

State and County Organizations

State Wildlife Agencies

Industry Representatives (Chemical, Equipment, Mining, Seed)

Educational Institutions

Ranchers

Canada

Mexico

Those who did not attend the San Antonio annual meeting missed a good one. Attendance was excellent and the program was varied and provided interest to all. W. R. Chapline, former Forest Service Director of Range Research, 1929 to 1953, and a long-time advocate of the Workshop, talked to the group about the early beginnings of the Range Seeding Equipment Committee, the predecessor of the Workshop. Chappy's talk provided an excellent review of the original purposes and the early proponents of this Workshop.

Bill Currier, Forest Service retiree and former chairman of the Workshop; Mike Cwik, Dames & Moore consultants; Ben Wolcott, Pittsburg and Midway Coal Mining Co.; and Don Calhoun, Bureau of Land Management (BLM); were the discussion leaders who kept everything moving in a timely manner. Workgroup chairmen presented reports on the current activities of their individual workgroups.

Charlie Heinrich, Horwood Bagshaw, Ltd., traveled from Clarence Gardens, South Australia, to talk about dryland farm and range equipment in Australia; Don Calhoun, BLM, gave a slide presentation on revegetation equipment in West Germany and the Soviet Union; while Gary Frasier, Science and Education Administration, talked about the benefits of the Dixon land imprinter. During the evening session Dick Hallman, MEDC, and Dan McKenzie, SDEDC, reported on the work currently underway at the Forest Service Equipment Development Centers in Missoula, Mont., and San Dimas, Calif. Tex Schofield, Forest Service, discussed equipment for trapping wild horses. Bland Richardson, Forest Service, gave a slide presentation on the equipment used in the Surface Environment and Mining (SEAM) program.

Don Mellgren, Fish and Wildlife Service, Elkins, W. Va., and Bill Plass, Forest Service, Princeton, W. Va., discussed a proposal from the Council for Surface Mining and Reclamation Research in Appalachia inviting VREW to affilitate with the Appalachian group to form the American Land Reclamation Association. The purpose is to coordinate activities between the two groups, avoid program duplication, and share information. It is intended that each organization could retain its present identity and continue with its own operations as before. A copy of the proposal is enclosed in this report, page v. We would appreciate comments on this proposal from

all participants in the Workshop. Address your replies to Vern L. Thompson, VREW, Forest Service, USDA, Box 2417, Washington, D.C. 20013. We have also received a letter from the Canadian Land Reclamation Association suggesting the formation of an internation association of land reclamation. We should know more about this after that group's June meeting.

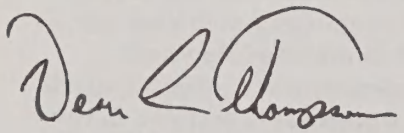
Other topics discussed were the EMRIA (Energy Mineral Rehabilitation Inventory and Analysis) program, research in mining equipment, practical application of mining equipment, instrumentation of disturbed lands, coal mine reclamation in Colorado, and arid land equipment. Each of the papers presented at the Workshop is included as part of this report, together with the Workgroup reports.

The Workshop annual meeting is the place for all those interested in the development of equipment and methods for land revegetation and rehabilitation to meet and share their interest and knowledge. Those of you who are interested in serving on a workgroup can write to the appropriate chairman and let him know of your desires.

Interest in the Workshop is growing each year. We are pleased with the increased participation by those people from private industry. To those who came from Canada, Mexico, and Australia we extend an invitation to meet with us again next year.

Casper, Wyo., is the site for the next annual meeting on February 11 and 12, 1979, at the Ramada Inn. While we were slogging through the cold, wind, and rain in San Antonio all week, Casper was basking in sunshine.

Mark your calendar now and invite your friends to VREW in 1979, Casper, Wyo.



Vern L. Thompson, *Chairman*

Affiliation with Other Land Reclamation Associations

Don Mellgren, Fish and Wildlife Service, introduced a proposal for the consolidation of the Vegetative Rehabilitation and Equipment Workshop (VREW) with the Council for Surface Mining and Reclamation Research in Appalachia (CSMRRA). Basically, the proposal calls for each group to retain its present functions under an umbrella title of the American Land Reclamation Association. VREW would be identified as the Western Division and CSMRRA as the Eastern Division, with the 100th meridian as the dividing line. Organizationally, each group would select representatives to act as liaison for the coordination of studies and research, information transfer, etc.

Dr. Bill Plass, Forest Service, chairman of the CSMRRA, described the history, objectives, and activities of this organization.

Dr. Allen Perry, geological engineer for Argonne Laboratories, described the capabilities of Argonne and other representative members of the CSMRRA.

Contents

Early Beginnings...

W.R. Chapline, *Retired Chief, Division of Range Research, Forest Service*

When I think of the start of these Workshops, my thoughts go back to two meetings with War Production Board representatives during World War II, and to earlier actions.

The first meeting was in the Secretary of Agriculture's office with representatives of the wool unit, mostly woolen manufacturers. They made a strong plea for increasing the sheep herds on National Forests of the West so they might have more wool, which was badly needed. The Forest Service at the start of World War II had decided it would not make the same mistake it made in World War I, when cattle numbers grazing on the National Forests were increased as a war meqsure. I emphasized at that meeting that we considered our ranges fully stocked and that purring more animals on them would result in overgrazing and might decrease wool production.

The second meeting was in my office, when a Chicago packer wanted more cattle in the West for beef production. He brought maps he or others in the War Production Board had prepared, showing that many more acres per cow prevailed in the Western States than in the Midwest. He felt confident that we should fill up those ranges to more reasonable acres per cow. Again I explained the position of the Forest Service.

One might ask, why did the Forest Service take that position. A bit of earlier history may explain:

Albert Potter, a former sheep and cattle grower in northern Arizona, served as the Arizona Wool Growers main representative when Pinchot and Coville considered whether sheep grazing on the Forest Reserves of northern Arizona should be eliminated. They decided that such grazing could be permitted if properly managed. Pinchot brought Potter into the Bureau of Forestry and made him Chief of the Branch of Grazing in the Forest Service when it was formed after the Forest Reserves were transferred to the Department of Agriculture in 1905. He gave him the job of overcoming the overgrazing then prevailing, as well as on the greatly enlarged National Forest area created by President Roosevelt in 1907. Drastic reductions were made between those dates and 1915, especially on the larger outfits with inadequate or no commensurate ranch property. Also the grazing seasons were shortened, especially in the spring. Unused range areas were also opened to grazing. Much of the overgrazing had been overcome and many depleted ranges were on the mend.

Then the U.S. entered World War I and the Hoover Commission requested increased stocking as a war measure, with a view to increased meat supplies. Although James T. Jardine, Chief of the Office of Grazing Studies, advised against it, other than to properly stock any ungrazed areas. Nevertheless, the word went out to the field and additional cattle were added on many National Forests. It is doubtful that any increase in meat production resulted. In fact, I later reviewed the Bureau of Agricultural Economics cattle figures for 1917 and 1918 in the 11 Western States. As I recall, cattle numbers increased, but beef production did not. Many of the more favorable National Forest grazing areas again became seriously depleted and often practically devoid of palatable grasses. It took more than 30 years to overcome much of the damage.

During the World War II period there were many open, park-like areas which had not recovered from prereservation or World War I depletion. They were in poor or even very poor condition, producing only at most a few percent of their potential productivity. Those two War Production meetings emphasized that as a war measure, the Forest Service should test throughout the entire Western National Forests effective seeding procedures and possible adaptable species proven by small research plots, with a view to providing greater forage production.

With support from Walt Dutton, Chief of Range Management, who was responsible for grazing administration on the National Forests, the Chief submitted supplemental budget requests. These were approved by the Secretary of Agriculture and the Bureau of the Budget for $75,000 for range reseeding research (down from the original request) and $100,000 for reseeding.

I had to support those requests before both the House and Senate Agricultural Appropriation Committees. Both emphasized we were in a war and research takes several years to obtain results. When I explained that we had in mind 1 to 10 acre tests of species and seeding procedures proven on small plots, both estimates were approved.

Early reseeding research in the 11 Western States had shown only limited success. Hurtt started small-scale reseeding tests in 1930 with President Hoover's emergency employment funds. In cooperation with the Montana State Extension Service, he hired farmers and ranchers recommended by county agents, in many eastern Montana counties. He tested both depth of furrows for seeding and amount of seed per acre, as well as species. Satisfactory procedures especially adapted to the plains were proven successful. By the midthirties, the Forest Service had embarked on a substantially increased program of range reseeding research at all

Western Forest and Range Experiment Stations, but especially at the Intermountain, largely with emergency funds. A substantial amount of knowledge had been developed on a wide variety of sites as to what, how, and when to plant. But with the war and tighter funds it had not been possible to move from the small experimental plots to larger scale seedings to test the suitability of procedures developed. In other words, we had some good information to move ahead with, but needed larger test seedings before finally recommending large-scale seedings.

With funds assured by the new appropriations, Dutton recommended, and the Chief approved, that we use both as a unit: Research would be responsible for the tests. Administrative officers would assist in the selection of areas where tests would be made, help get necessary equipment and any local personnel that might be hired, and, in fact, facilitate the tests in any other appropriate manner.

The program proved successful far beyond our fondest hopes. We seeded 20,000 acres with those small test areas and had a 90 percent success. The main problem was breakage of the available equipment, much of which was designed for crop production, not range seeding.

Stockmen, however, were so impressed with results that they urged the Department and Congress to increase the reseeding funds for the Forest Service to $500,000. That occurred. That in turn meant seeding larger areas and employment of help which might not fully appreciate the difficulty of using available equipment on difficult range sites. Reseeding of larger areas could result in more serious breakage and costly interruptions in the work.

The problems lay not only with compacted and rocky soils on open, depleted, park-like areas, but also with often heavy cover of brush and rough, rather steep terrain on other sites. Such situations led to breakage or poorly functioning equipment for controlling the brush, preparing the soil, and planting the seed.

In 1945 a meeting was called in Utah of Western regional administrative and research men to review the state of the art and what needed to be done. It was the unanimous recommendation of that group that major emphasis be placed on testing, adapting, and designing equipment to carry out the range seeding work; also to avail ourselves of the skills of the Equipment Development Center, then at Portland, Oreg.

An interregional administrative and research committee was established with Joe Pechanec as chairman. He had transferred to the Pacific Northwest Station in the fall of 1945. The group was to work closely with Ted Flynn and Tom Colwell of the Equipment

Center. The work started almost immediately after Pechanec arrived in Portland: reviewing needed improvements in rails and pipe harrows for brush control, plows for ground preparation and drills for seeding, and evaluation of available equipment.

A major stride was made when the Committee learned of the stump jump plow being used in Australia. One was imported and tested in several locations in the West. Incidentally, the purchase of a foreign-made plow caused considerable anguish on the part of some of our fiscal people. The plow had some very desirable principles but was inadequate in materials and construction to stand up under continuous range use. The principles led to the design and construction of the brushland plow.

The second big stride, so Pechanec tells me, was the development of the rangeland drill. Experimental work had shown the desirability of uniform distribution and coverage of the seed. Commercially available drills used on range seeding operations quickly ended up as piles of junk. John Kucera, who was range staff man on the Fremont Forest in Oregon, came up with ideas for improving drill performance and durability. These were taken by the Equipment Development Center, improved on, and the rangeland drill developed.

Ted Flynn's enthusiasm and knowledge played no small part in the fruitfulness of the Committee effort. He never lost his interest even though his Portland work was consolidated with the Arcadia Equipment Development Center in California and later transferred to San Dimas, Calif.

One other feature of the Committee's work that immeasurably added to its success was the recognition rather early that there were people in other agencies who could contribute knowledge and experience to the effort, as well as profit from it. BLM was invited in in 1949 at the Denver meeting. Hafenrichter of SCS may also have been there. In 1951 at Billings we extended participation to many other agencies.

Pechanec deserves great credit for the successful start and early efforts of these Workshops, which have now expanded so successfully over the years.

Workgroup Reports

Information

Ray Dalen, *Chairman*

Information Workgroup Support (ED&T 7083)

The effective dissemination of information is a challenge that any group or organization engaged in development work faces. Information transfer, however, is an activity often put aside because the work is routine and not appealing to most people engaged in development work. But in the long run, publishing or otherwise making known what has already been developed should be the first goal of a group engaged in furthering technology. This is especially true in resource management, where field units are widely scattered and personnel usually work independently. It is difficult for many land managers to stay abreast of the best tools and techniques available.

The Information Workgroup was begun in 1975 to disseminate information concerning Workshop goals and accomplishments, including technical reports, visual aids, and general material. A mailing list was compiled of Federal and State agencies, national organizations, universities, private industry, and individuals interested in Workshop activities and projects. In 1978 the Workgroup plans to begin building a library of reports concerning equipment for range rehabilitation. Work for the coming years will be determined by the members of the Information Workgroup. As in past years, the annual report will be prepared and distributed under Workgroup auspices by the Missoula Equipment Development Center.

Range Equipment Handbook (ED&T 8022)

The *Range Seeding Handbook* was probably one of the best products of the old Range Seeding Equipment Committee during its 25-year existence. Last printed in 1965, the handbook served as a bible for many working in range habitat improvement. Although the book is out of print, the Forest Service Equipment Development Centers at Missoula and San Dimas still get requests for it. Unfortunately, no publication has come along to take its place. Because the Workshop is looked to for leadership in rangeland equipment, a project was begun to update the handbook.

The objective for 1978 is to gather information concerning suitable equipment and complete a rough draft. In 1979 the handbook will be reviewed by Workshop members, edited, and printed and distributed.

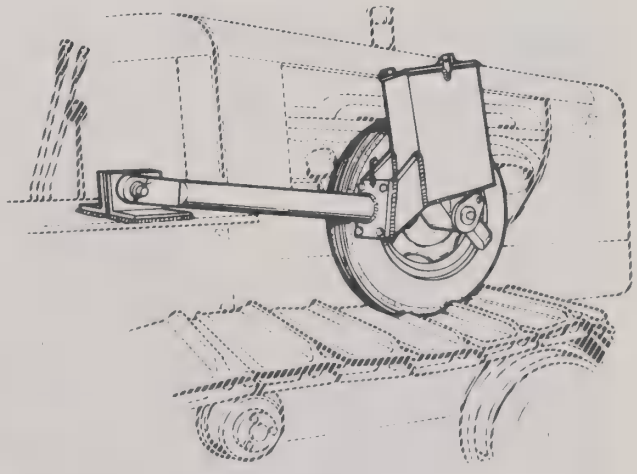
Seeding and Planting

Dick Eckert, *Chairman*

Workgroup Activities

1. The Forest Service San Dimas Equipment Development Center (SDEDC) published an *Equip Tips* on seed dribblers (July 1977, no. 7722 1307). Seed dribblers mount on crawler tractors and meter seed onto the track, which then carries the seed forward dropping it in front of the track. The seed is pressed into the soil as the tractor passes over. This concept was inspired by the observation during conventional reseeding operations that some of the best stands sprung up in the tracks left by the tractor.

Two seed dribbler designs are commercially available. One is a fluted, force-feed like that used in most grain drills. It is manufactured by Laird Welding & Manufacturing Works, 531 South Los Banos Highway, Merced, Calif. 95340. A second type, called a thimble seeder, can be obtained from Stanley G. Mitchell, 116 Sage Rd., Fredonia, Ariz. 86022. This design uses a



Fluted, force-feed seed dribbler mounted on crawler tractor.

spoked wheel with seed thimbles mounted on the ends of the spokes. The thimbles move through the seed. The number, size, and shape of the thimbles control the amount of seed each thimble picks up. This device has the special capability of metering light, fluffy grass seed.

2. Field tests were conducted of the interseeder for rocky and brushy areas (ED&T 2532) at the Intermountain Forest and Range Experiment Station, Ephraim, Utah.

3. The rangeland drill with seedbox capable of metering trashy seed is being used on the Jornada Experimental Range of the Science and Education Administration (formerly Agricultural Research Service), Las Cruces, N. Mex.

Backside view of thimble seeder showing spokes with thimbles attached.

Interseeder for Rocky and Brushy Areas (ED&T 2432)

Reported by Richard Stevens, Utah Division of Wildlife Resources

Interseeder Description

Interseeders seed desired species into existing range vegetation, simultaneously preparing the site and planting the seed. However, they are not designed to operate in rocky and brushy areas. The Forest Service San Dimas Equipment Development Center (SDEDC) was assigned a project to develop a demonstration interseeder that could operate in such terrain.

SDEDC engineers devised a five-component interseeder: prime mover; implement-carrying hitch; single-disc trencher; seed-metering device; seed-transfer system.

The prime mover is a John Deere model 350 diesel-engine crawler tractor, rated at 42 drawbar horsepower, equipped with a three-way dozer.

The implement-carrying hitch mounts on the tractor at its real hitch point. In this way, the implement remains in the ground and continues working even when the tractor pitches up and down on uneven ground or turns to avoid large rocks and tree stumps.

The single-disc trencher is a reversible plow having a 28-inch diameter disc. The disc angle can be adjusted 45 degrees left or right. The disc is spring-loaded so if the disc hooks a stump or rock, it can ride over without being damaged. A gage wheel at the rear of the plow assists in maintaining a constant cut depth.

The seed-metering device is a thimble seeder, a seed dribbler mounted on the side of the tractor. A rubber-tired wheel that rides on and is driven by the tracks of the tractor powers the seeder.

The seed-transfer system is made up of: turbocharger, venturi tube, conveying tube, cyclone separator, drop tube, and drag chain.

Interseeder prime mover is a John Deere model 350 crawler tractor.

Field Test Program

The Utah Division of Wildlife Resources in cooperation with the Intermountain Forest and Range Experiment Station obtained the interseeder from SDEDC for field testing. To do effective interseeding into existing vegetation, scalps need to be (1) deep enough to remove all seeds, crowns, and rhizomes of existing vegetation; (2) wide enough to allow seeded species to become established before reinvasion occurs from surrounding vegetation; and (3) of such a shape and size as to be effective water harvesters.

The interseeder was tested at three locations in Utah. It was first tested at two high elevation sites in the subalpine on the Wasatch Plateau above Ephraim, Utah. The first test area had a 4-percent slope dominated by Letterman needlegrass and Rydberg penstemon, with some mountain brome and mountain geranium present. Soil was a deep clay loam. A trench 17 inches wide and 12 inches deep could be made without difficulty. The crowns and reproductive material of all existing vegetation were removed and water catchment basins were made.

The second test area was relatively flat, dominated by herbaceous sage and Letterman needlegrass. Soil was a shallow, rocky clay loam underlined by layers of limestone. Because of the rock in the soil and the subsurface layers of limestone, trenches only 8 to 14 inches wide could be made. On these sites, the John Deere 350 crawler tractor had sufficient power to operate the seed-metering device and single-disc trencher. The implement-carrying hitch was highly versatile and performed well under all conditions. The single-disc trencher with its accompanying hydraulic system appeared well designed. It scalped in a wide variety of shapes and sizes.

Tests of the seed transfer system were conducted using a number of seed types. The principle behind the thimble seeder and seed-transfer system is good. When the turbocharger was working, it did an excellent job. The first turbocharger did not work; it was rebuilt and still did not work. A second turbocharger was installed and worked satisfactorily.

Plantings were accomplished using seeds of single species as well as mixtures of grass, forb, and shrub seeds. Seeding trials resulted in various results for seed of different species. Hard, smooth-coated seed like alfalfa, clover, and bitterbrush and smooth-coated grass species like crested and intermediate wheatgrass and hard fescue moved through the seed-transfer system without problems. Plumed seed from rabbitbrush and aster, seed with chaff and floral parts like sagebrush and winterfat, rough and hairy seed of Great Basin wildrye, mountain brome, and uncleaned timothy, and seed with any sticks, leaves, or other trashy material did not move through the system without encountering some problems.

Modifications Made. Larger and wider thimbles were fabricated to obtain desired results with each seed type. To prevent some types from hanging up in the seed bin and to create an even flow of seed, the opening between the seed bin and seed reservoir was increased in width and height; the angle, length, and width of the agitators also were increased (⅛-inch-thick belting). This was required, especially for sagebrush, aster, mountain brome, and winterfat seed.

The large flexible engine exhaust pipe was found to be inappropriate in that it moved around and shook so much it was continually being disconnected from the turbocharger. Consequently, the exhaust system was rerouted throught the tractor's original exhaust system, which resulted in satisfactory performance.

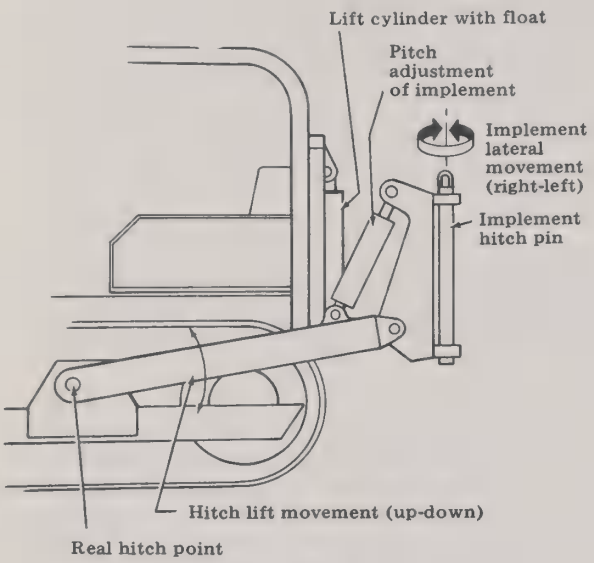
Modifications Needed. Modification to the plastic transfer hose and drag chain need to be made. The plastic hose that carries the seed from the cyclone separator to the cut furrow is placed so effective seeding can only be accomplished when the disc is casting soil to the left. When working on the contour, soil needs to be cast downhill. This can only be accomplished with the tractor traveling in one direction. Likewise, the drag chain attachment point needs to be repositioned to a more center point behind the disc so the chain drags in the center of the furrow. By repositioning the drag chain and plastic hose that carries seed from the cyclone separator to the furrow, soil can be cast in either direction and seed placed in the furrow and covered.

Any trashy material or seeds of sagebrush, rabbitbrush, aster, or winterfat can plug the venturi opening. Consequently, the size of the venturi tube opening needs to be enlarged.

A blade to clean the disc needs to be installed if it is to be used in moist, heavy soils because the disc does not clean itself.

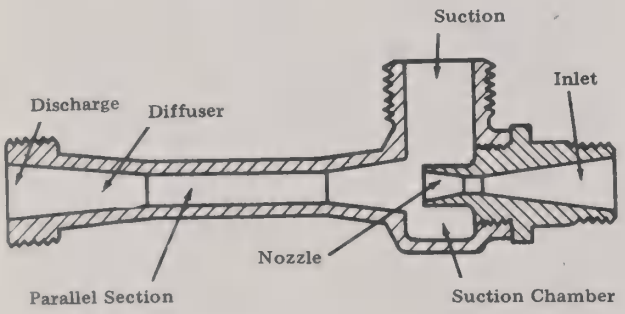
Third Test Area. The third site on which the interseeder was tested was within the pinyon-juniper, sagebrush-grass type. This area had been seeded to crested and intermediate wheatgrass over 20 years ago and is now dominated by intermediate wheatgrass. There are tens of thousands of like wildlife acres dominated by perennial grasses and lacking needed shrubs and forbs. These areas need changes in species composition so improvement in forage quality and quantity and habitat and escape cover can take place.

Three types of scalping equipment were tested on this site relative to their effectiveness in removing perennial grass competition and creating an environment for the successful establishment of the seeded species. The equipment types were: single-disc trencher; Sieco fireplow; modified Hansen scalper-seeder.

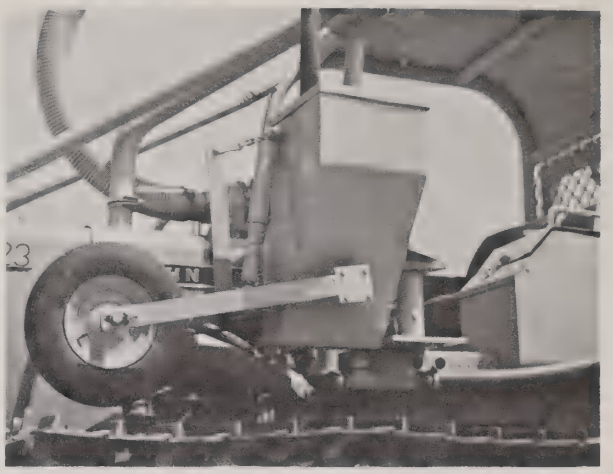


Implement-carrying hitch schematic.

Gage wheel on single-disc trencher maintains constant furrow depth.



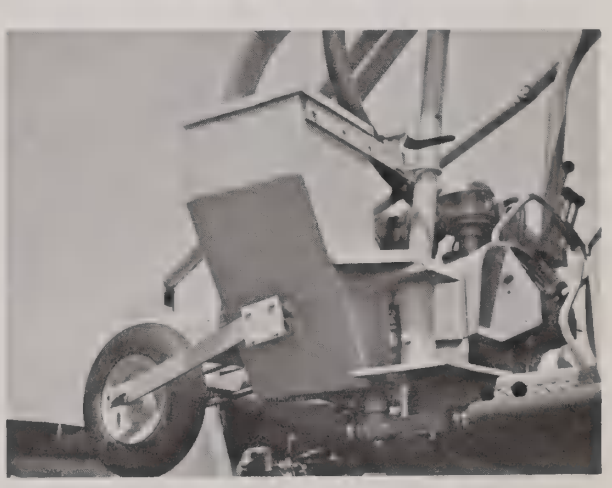
Cross-sectional view of venturi tube.



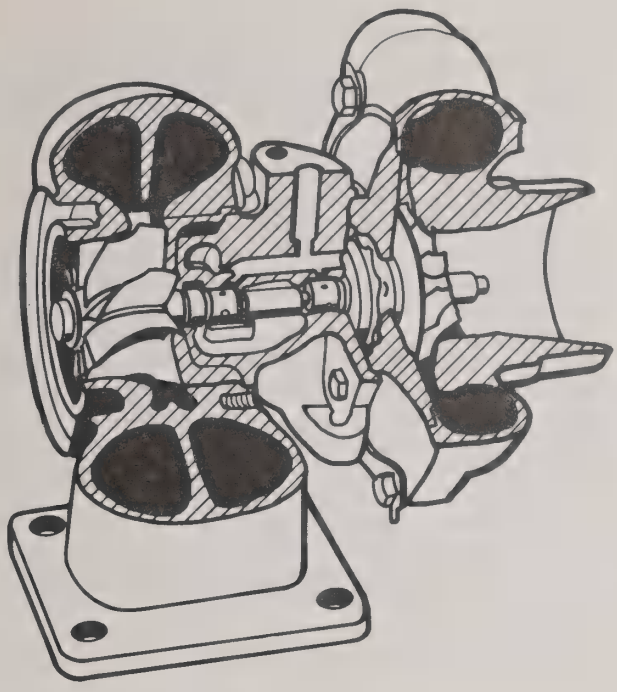
Thimble seeder mounted on side of interseeder prime mover.

Seed discharged from the thimble seeder enters the venturi tube with the aid of gravity and negative pressure. As the seed enters the tube's suction port, high-velocity air from a turbocharger carries the seed through 2-inch tubing to a cyclone separator on the trencher. The turbocharger is mounted on the tractor's exhaust manifold port. A flexible metal pipe carries away the turbocharger's exhaust gases for release above the tractor's canopy. The turbocharger is also an acceptable spark arrester. Air supplied to the turbocharger is pulled through a separate air filter atop the tractor's canopy. The incoming air must be filtered so no dirt or foreign particles can enter the airstream and damage the turbocharger.

The cyclone separator decreases the velocity of the seed and separates it from the airstream. (If the seed were blown directly from the tube into furrows, it is unlikely it would stay.) The seed then drops by gravity and low air pressure through a smaller plastic tube into the furrow cut by the disc plow. After the seed falls into the furrow, a drag chain attached to the rear of the plow covers the seed with a small amount of soil.



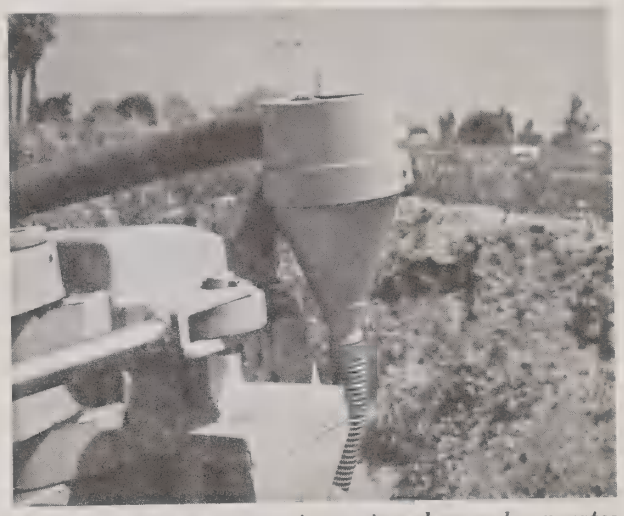
Venturi tube mounted on thimble seeder.



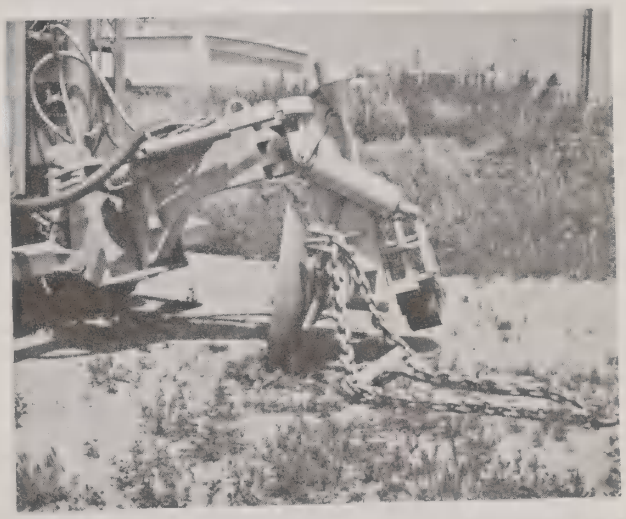
Cutaway view of typical turbocharger.

Turbocharger mounted on tractor with air filter and exhaust pipe.

Plastic tubing carries seed from venturi tube to cyclone separator.



Cyclone separator mounts on trencher and separates seed from high-velocity airstream.



Cyclone separator, plastic drop tube, disc plow, and drag chain at rear of trencher.

Sixteen species were seeded singly and in mixtures in an effort to determine the effect each scalp has on the establishment and growth of each. Species seeded were:

Big sagebrush	Mountain sagebrush
Fourwing saltbush	Gigas fourwing saltbush
Prostrate Kochia	Bitterbrush
Cliffrose	Alfalfa
White rabbitbrush	Mountain rabbitbrush
Cicer milkvetch	Sicklepod milkvetch
Pacific aster	Small burnet
Lewis flax	Showy goldeneye

To obtain desirable seeding rates for the 16 species, thimble size was changed six times.

The modified Hansen scalper-seeder being pulled by a rubber-tired tractor made a scalp 36 inches wide and only 4 inches deep in the center. The scalper would not go down through and under the heavy intermediate rhizomes, consequently it did not remove all crowns or rhizomes. This will result in the grasses being within the scalps this coming season competing with the seeded species

The single-disc trencher could only make a scalp 14 to 16 inches wide and 8 inches deep. Within the scalp, the crown and rhizomes of all grasses were removed.

Data obtained from previous work and work conducted by Gordon VanEpps, Utah Agricultural Experiment Station, indicates that scalps wider than 18 inches are needed, especially when establishing plants into perennial grass stands. A two-disc implement could be used to increase scalp width.

The Sieco fireplow creates a scalp 39 to 41 inches wide, 8 to 10 inches deep in the center, and 6 to 8 inches deep on the sides. Complete removal of all grass crowns and rhizomes was accomplished. Because of the depth and width of the scalp, reinvasion of the scalp by the intermediate rhizomes should not occur for 4 to 8 years, allowing sufficient time for the seeded species to become established.

The scalps are acting as effective water harvesters this winter, with the Sieco fireplow scalp appearing to be harvesting more water than the single-disc trencher scalp. We will not know the effectiveness of these scalps until the seeded species have had a chance to express themselves in the coming season.

Conclusions. The interseeder as modified in the field during the test program proved to be a workable unit. With further modifications already suggested, plus feedback from additional tests, it can be the basis for a prototype that should lead to a production model.

The arrangement of having the thimble seeder mounted on the tractor can be advantageous for three reasons: First, the operator is better able to see if the seed is being metered properly than if the thimble seeder was mounted on the trencher. Also, a closer check can be kept on the seed supply. Second, having the tractor's tracks power the seed-metering device eliminates the need for powering the metering unit with a separate ground driver wheel; such a wheel would require protection to function properly. And third, more protection from external damage is afforded the thimble seeder by having it mounted on the tractor instead of on the trencher. The Hansen dribbler also could be used in place of the thimble seeder.

Recommendations. These design modifications should be made to the demonstration interseeder:

1. Provide a blade to clean the disc.
2. Use a wide scalp — a double-disc trencher or the fireplow may provide this.
3. Reposition the seed drop and drag chain so the single- and double-disc trenchers can cast in either direction and still place seed in the furrow and cover it.
4. Make a larger opening in the seed-transfer system venturi tube so large, trashy seeds (such as sagebrush, aster, and winterfat) will not plug up the opening.

Field testing of the test-bed interseeder should contiue so additional data for a prototype model can be gathered.

Contour Furrow Seeding

Presented by J. Ross Wight
Science and Education Administration

Contour furrowing has been widely used as a surface modification treatment to reduce runoff and erosion on Western rangelands. The purpose of this presentation is twofold: (1) to discuss contour furrowing as a method of seeding inhospitable sites with introduced as well as native species and (2) to discuss innovations on contour furrowing equipment that could substantially reduce equipment costs and horsepower requirements.

Contour furrows aid in the establishment and production of range forage species by enhancing the soil water regime. Increased soil water results from the reduction of runoff and, in some cases, the trapping of snow. In eastern Montana, contour furrowing has been effective on both fine- and medium-textured range sites in establishing productive stands of introduced species such as Russian wildrye, regar bromegrass, and alfalfa. Contour furrowing is a practical and effective water conservation treatment, especially on fine-textured range sites, and provides a means of establishing plants on sites where plant establishment is generally very difficult. Contour furrowing may also provide a means of establishing plants during drought years.

A lister-type furrow constructed by Mr. Frank Sparks of eastern Montana has been used effectively to apply contour furrowing treatments. This furrower constructs flat-bottomed furrows up to 80 cm in width and 5 to 12 cm deep at 1- to 2-m intervals. Intrafurrow dams are created at desired intervals by briefly raising the lister shovels out of the ground, leaving about a meter of undisturbed sod. Failure of the intrafurrow dams as constructed by the Arcadia model B contour furrower has been a major reason for the breakdown and failure of contour furrowing treatments. The intrafurrow dams of undisturbed sod created by the lister furrower effectively overcome this problem. Another important feature of the lister furrower is a low horsepower requirement; it can be pulled by large farm-type tractors. Such a feature makes contour furrowing less expensive and more available to individual ranch operators.

Further research is warranted on a lister-type furrower, particularly in regards to seeding attachments.

Manufacture of Rangeland Drills and Seed Dribblers

Reported by Roy Laird, Laird Welding & Manufacturing Works

I was interested in hearing Bill Currier speak of Tom Colwell, the engineer and designer of the first model of the rangeland drill, for my company received the first contract for rangeland drills, some 17 units, back in 1955. To date we have manufactured some 190 units for U.S. Government agencies (Forest Service, Bureau of Land Management, Bureau of Indian Affairs, Soil Conservation Service), individuals (ranchers, mining companies, and reclamation contractors), and several foreign countries (Iran, Canada, British Honduras, and Saudi Arabia).

We have experienced some problems with the disc spindle bearings in Kansas and northwestern Kentucky from the very fine, highly abrasive sand found in these areas. To eliminate this problem the Oilite and steel bushings on the opener arms have been replaced with a large triple seal, nonlubricating ball bearing which then also required a larger, heavier, opener arm lower casting and a revised heavier disc backup plate casting. Slow delivery from the factory of the triple seal bearing delayed completion and delivery of a number of rangeland drills. Also, 12- to 18-month delivery times for the John Deere 8000 series grainboxes slowed completion and delivery. However, for the first time in a number of years we now have both the model BB and 8000 series rangeland drills in stock for immediate delivery. As of February 1978, costs were as follows:

Model	*Cost (Full size) (FOB Merced)*
BB (plain grain)	$7,688
BB (fertilizer)	$8,623
8200 (plain grain)	$8,982
8250 (fertilizer drill)	$9,595
8300 (plain grain)	$9,980
8350 (fertilizer drill)	$10,250

All models can be equipped with grass seed attachment — add $669.

We have developed a trashy seedbox for the rangeland drill and plan to use the planatery speed control box used on the John Deere 8000 series drill fertilizer drives. This speed control box has 25 speeds for varying the seed metering rate.

This last year we manufactured and delivered a number of Hansen seed dribblers. The seed dribbler mounts on a crawler tractor fender and is powered by a rubber tire driven by the track. Seed drops onto the track and then falls to the ground in front of the moving track, which presses it into the ground.

Rangeland Drill with Seedbox Capable of Metering Trashy Seed

Reported by Carlton H. Herbel, Science and Education Administration

The Jornada Experimental Range at Las Cruces, N. Mex., has continued to test the rangeland drill equipped with a seedbox made by Industrial Agricultural Services International, Inc. This seedbox is capable of metering trashy seed common to the Southwest. Black and sideoats grama, yellow bluestem, and fourwing saltbush were seeded. Two deep furrowing arms were mounted on one side of the drill, but we were unable to make furrows over 1-inch deep on clay loam soils and 3 to 4 inches deep on loam soils. The seed feeding tubes on the deep furrowing arms were not at a steep enough angle to satisfactorily use the chaffy seed.

Arid Land Seeder

Carlton H. Herbel, *Chairman*

No further development of the arid land seeder is planned this fiscal year. During the past year an area infested with creosotebush on the Jornada Experimental Range was rootplowed and seeded by the prototype equipment developed in the 1960's. We used Lehmann and Boer lovegrasses, black and sideoats grama, yellow bluestem, and fourwing saltbush. We are planning to treat a total of 200 acres with this equipment so that we can study the effects of this operation on the ecosystem.

Arid land seeder.

Plant Materials

Gil Lovell, *Chairman*

1977 Activities

The Plant Materials Workgroup was active in 1977 compiling, revising, and updating previous reports on new or improved plant materials. The goal of publishing an extensive listing of plants released for rangelands or general rehabilitation proved to be too ambitious for the time and manpower available to this Workgroup in 1977.

The group finds itself at a point of reorganizing and bringing in new members to replace several people who find themselves unable to remain as active as they feel they should. The group will continue to maintain a membership composed of representatives from Federal agencies (Science and Education Administration, Bureau of Indian Affairs, Bureau of Land Management, Soil Conservation Service, Forest Service), university and experiment station researchers, and industry (particularly the commercial seed producers).

The goals for 1978 will be set at a somewhat modest level to insure completion of projects. Goal I will be to complete and publish a revised and updated listing of released and available plant materials suitable for rangeland rehabilitation. Goal II will be the review at the 1979 Workshop of the most promising plants now being evaluated by universities, the Science and Education Administration, Soil Conservation Service, and the Forest Service. This review is being planned as a slide presentation of plants on problem sites, with brief descriptive statements by the respective researchers.

Ecosystem Data for Predicting Forage Alternatives

Presented by Tom Davidson,
Science and Education Administration

In the Plant Taxonomy Laboratory at the Agricultural Research Center at Beltsville, Md., Dr. James A. Duke and Thomas C. Davidson maintain an expanding computerized data base of plants important for forage, food, fibers, and oil in the world economy. Each of the 25,000 records in the data base is made up of the species identifier, the location, latitude, longitude, elevation, as well as climatic and soil information that corresponds to the location where the plant is under production. Supplied with the appropriate ecological parameters of a given remote location, the data base can be queried for a listing of plants that are under production in similar ecological situations around the world, and would presumably have a positive economic potential in the area under consideration. If the ecological parameters for the area in question are not known, it is possible to deduce them if a sufficiently complete list of weeds from the area is provided. Subsequently, the list of cropping alternatives may be generated.

Although the data base is large enough to generate broad-brush sketches of the ecological amplitudes of cultivated, native, and weedy species, it needs to be doubled, at least, to permit statistically reliable fine-brush deductions. For that reason, the Laboratory is collaborating with other stations, in the U.S. as well as abroad, to assimilate more data to augment the data bank. Collaborating stations will receive copies of the consolidated data in return for filling out appropriate questionnaires.

Seed Harvester

A. Perry Plummer, *Chairman*

Backpack Seed Collector (ED&T 2623)
Presented by Stephen B. Monsen, Forest Service

The two backpack seed collectors designed and fabricated under contract have been undergoing field tests. These tests have been encouraging to the extent they show that a backpack seed collector is feasible. However, the marginal performance of the current prototypes does not merit fabrication of units for field use. The present backpack seed collectors were designed with 6-inch inlets but have been operating satisfactorily with 3- and 4-inch inlets. These units weigh 44 pounds and have been judged too heavy and bulky. Making the seed storage volume smaller (from 1 to ½ cubic foot and reducing the inlet size will reduce weight and size.

Based on field tests of the two backpack seed collectors, specific requirements were developed for a backpack unit:

- Inlet air velocity: 7,000 fpm or greater. For most seed collection, air velocity should be as high as possible, but not less than 7,000 fpm; some seeds can be collected at lower than 7,000 fpm, however.
- Inlet size: 3 to 4 inches.
- No seed passing through the fan; seed separation before the fan.
- Seed storage: ½ cubic foot.
- Maximum weight: 34 pounds.
- Engine controls in easy reach of operator.
- Engine equipped with spark arrester.
- No hot spots that can cause fires.
- Engine equipped with fuel shutoff.
- Maximum sound level permitted from unit is 115 dBA at either of the operator's ears. For sound levels of 85 dBA or over at either of the operator's ears, muff-type hearing protectors must be worn.

Because of the marginal performance of the current prototype, the Forest Service San Dimas Equipment Development Center (SDEDC) is considering engineering changes, design alternatives, and new concepts. One new idea is to work with an air broom manufacturer to convert a unit to a seed collector. Another is to assemble a test-bed seed collector using a commercial air amplifier driven by compressed air. Also, SDEDC is negotiating with the University of California at Davis to enter into an agreement to design and fabricate a seed collector using new design concepts.

Prototype Seed Harvester for Fourwing Saltbush
Presented by Gordon A. Van Epps, Snow College

My work for the past several years has been with native shrub species. Guidelines for establishing seed orchards on cultivated crop land have been an important phase of this research. Emphasis has been with fourwing saltbush *(Atriplex canescens)* due to its wide adaptation, rapid growth, palatability, and variability.

A need developed in my research for some type of harvesting other than hand harvesting alone. It is difficult to obtain a complete seed yield from experimental plantings of this species by hand harvesting due to shattering during the harvesting, breaking of the brittle branches, as well as the labor involved. In cooperation with the Forest Service Intermountain Forest and Range Experiment Station, Utah State University Institute for Land Rehabilitation, and Snow College, along with limited funds scattered over several years, I have attempted to deal with that need.

A harvester to be effective in established seed orchards probably should be relatively small, easily maneuverable, versatile, economical, and noninjurious to the seed germ of the crop being harvested. This particular machine is a combination hand and mechanical harvester.

The machine, at present, is by no means a finished product, but I am showing an idea that needs improvement. There are a number of modifications yet to be made. These include size and shape of the seed collecting pans, nozzle shapes for harvesting seed on the ground, hose swivels and couplings next to the nozzles or pans, optimum hose size, hose and boom length, boom hose support, suction cut-off gates, a cyclone for forced air dispersion, a sacking Y with shut offs, a sacking platform, and possibly others.

This particular modified harvester consists of a 48-inch fan forage blower with direct attachment for maneuverability to a small farm tractor with the common three-point attachment. The centrifugal blower is powered from the power takeoff of the tractor with a maximum of 540 rpm.

The forage hopper has been removed and replaced by a more or less circular convex hood or bell with two 8-inch outlets for hose connections. The diameter of the hose couplings can vary depending on hose size. The present sizes include an 8-inch diameter hose on one side and a 6-inch hose on the other. A blank plate may cover one or the other holes, when only one hose is desired.

The flex hoses being used are 25 feet in length. This allows with the swinging booms to harvest both sides of the plant row on either side of the harvester or to

reach out to the second row, or further, depending on row width. It may prove more feasible to have shorter hoses and harvest from only one side of the plant, harvesting the other side as one travels back and forth between rows.

Some type of comb or spring-wire-tined rake is necessary for pulling or knocking the fruiting bodies off the plant and onto the harvesting pan where by air suction they pass through the hose and fall into the bag. We have tried a shag carpet rake and a modified lawn rake. The lawn rake seems to be the best, but is not the final tool.

The size and shape of the seed collecting pan and handle need additional study. It needs to be small and light enough for hand maneuverability, but adequate in size and shape to retain the seed being raked or knocked from the stems as well as retaining the air suction for seed removal. Sides of some design are needed for retaining the suction, and a lip is needed across the front of the pan to help retain the seeds until removed by suction. The handle should be of adequate size and at the proper angle to assure comfort for the operator. In line swivels are needed along with quick couplings between the hose and the collecting pan or nozzle. Obtaining the correct position of the pan for harvesting with these large hoses will be difficult without swivels for maneuvering the pan back and forth. The pan needs to be kept fairly level for retaining the harvested seed. With the present shaped pan there has been a slight problem of cleaning the seed off the pan. By lowering the hose end the seed has been sucked into the hose.

Nozzle designs for sucking seed off the ground and especially from under a large plant have not been studied. It would seem that a narrow, fan-shaped structure that is straight across the opening or possibly with one side (lip) longer than the other might be preferable.

The two booms are at present 14 feet in length and 8 feet above ground level. They are made for easy turning. The hose hangers when completed will be saddles under the hose with an adjustable chain extending to the boom for adjusting hose height over plants where necessary.

The seed bagging portion of the harvester has not been completed. This past summer we used a 10-inch flex hose from the fan housing with a burlap bag tied to the end for seed collecting and air dispersal. As we were changing bags for each individual plant this worked fairly well, except that time was wasted in lowering the tractor speed between each bag change. A permanent U-shaped pipe with a gated Y for holding two bags would eliminate some of these problems. Inserting a cyclone in the line with a gated Y for bagging at the outlet may be the final answer. A bagging platform connected to the harvester and extending behind it is being looked at as a possible need.

Speed of seed harvesting will naturally increase with experience and practice. It is questionable that its use will surpass the speed of harvesting by an experienced handpicker, but this breed is few in number. Normally they only harvest those plants fully loaded with seed and don't bother with complete stripping of the seed. It may also be easier to obtain laborers that will harvest with a machine as against hand labor.

The problem of seed injury while passing through the blower is being studied. This would not appear to be as injurious to fourwing saltbush seed as is the usual hammer milling process in dewinging the fruit bodies during the cleaning process.

OSU Seed Harvester

Presented by Richard W. Whitney,
Oklahoma State University

Harvesting chaffy seed has been one of the most difficult tasks to mechanize. The surface characteristics of the intact seed units of certain native and introduced grasses, for example, hairs, awns, and other inert appendages surrounding the caryopses, make their harvesting difficult. Seed size and indeterminate growth habits with variable head heights and maturity all contribute to the problems associated with mechanically harvesting such seed.

Harvesting technology for chaffy seeds has remained about the same since 1957. Harvesters in use are mainly modifications of combines and cotton strippers. A few stripping machines previously developed, such as the McCormick self-raking harvester[1] and the Armstrong stripper are also being used for chaffy seed stripping. More recent developments of experimental machines have utilized one or more of the following: (1) reels with rubber bats, (2) horizontally strung wires rotated to knock off seed, and (3) brushes. Strippers and vacuum harvesters represent the most recent advancements in equipment to harvest chaffy grass seed. These harvesters include at least one of the following three components: (1) a rotating drum with protruding spikes or wires which strip seed from the plant, (2) cutting and threshing mechanisms, and/or (3) fans producing vacuum for removing and transporting seed. Harvesting efficiencies with present equipment and methods are estimated at 20 to 30 percent for the chaffy seeded Asiatic bluestems to 60 percent for other native grasses.

The objective of this work was to develop equipment for harvesting grass seed (specifically the chaffy seeded species) which would increase current harvesting efficiency two to four fold and provide field capacities of 0.8 to 1.6 ha/hr. Other specifications applied to the design included a requirement that seed head heights of from 15 cm to 122 cm be harvestable, that the seed collection system be adaptable to bulk handling methods, and that the resulting machine be pull-type and compatible with farm tractors.

[1]Kelly, J.B. 1941. Machinery for harvesting bluegrass seed. J. Agric. Eng. 22: 353-354.

Stripper Design

Five machine elements were arranged in series to accomplish the harvesting functions. A stripping reel, cross-feeding augers, a material handling fan for pneumatic conveying, a screen separator for removing seed from the airstream, and a collection hopper were mounted on a commercial windrower chassis (fig. 1). All rotating elements were driven hydraulically.

Stripper Reel. The stripper reel was designed to bend seed heads over a concave plate where the flailing action of the reel could remove the seed parts of the plants (fig. 2). Stripped material was thrown to the rear into the cross auger. Aggressiveness of the stripping action could be increased by faster reel speed or by changing to reels with larger diameter flails. Four reel-flailing materials were evaluated: (1) rubber fingers commonly used for turkey feather removal, (2) stainless steel wire 1.6 mm in diameter, (3) 1.6 mm diameter nylon, and (4) 3.2 mm diameter nylon.

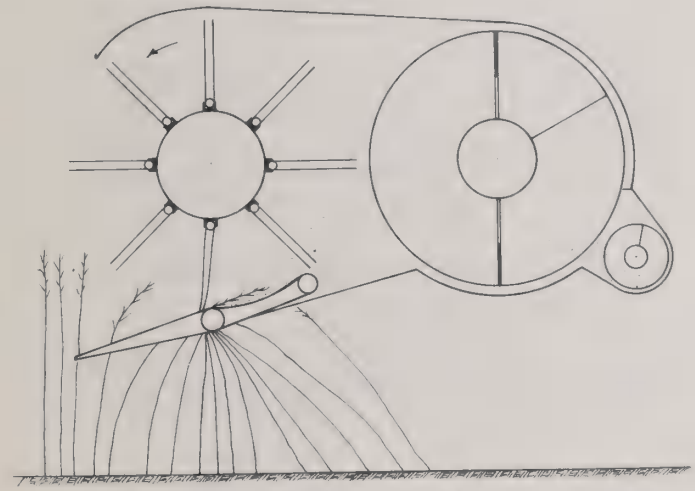


Figure 2.—Stripper reel bends seed heads over a concave plate where reel flailing action removes seed parts from plants.

Cross Augers. A 51-cm diameter auger, parallel with and behind the stripper reel, moved the stripped material to the center of the header. Two 0.64-cm-thick belting strips, 15 cm wide by 51 cm long, were mounted at the center, 180° apart, on the auger shaft to flip the material into a 15-cm diameter feed auger. This auger metered the stripped product into the pneumatic conveying system.

Pneumatic Conveying System. The pneumatic system passed the stripped material through an 18-cm diameter flexible tube, into a 46-cm material handling fan, and up an 18-cm diameter smooth pipe. It was then removed from the airstream by a screen separator and dropped into a hopper. Design airflow of the pneumatic system was 35.3 m^3/s at 1,421 m/s.

Figure 1.—Oklahoma State University grass seed harvester.

Separator. The separator used to remove the harvested product from the airstream consisted of a simply designed screen box. Perforated metal used for the separator had 37 percent open area with 1.14-mm holes. Material was dropped from the separator into a 1.2 x 1.2 x 1.5 m canvas bag designed for bulk handling.

Hydraulic Circuitry. Figure 3 presents the hydraulic circuit used to drive the harvester system. A PTO-driven gear pump (2.0 L/s) provided hydraulic power to three motors each separately speed controlled by a flow control valve. Adjustable priority flow dividers maintained individual motor speeds independently of their respective loads. The system was protected with 10-micron filters. Hydraulic cylinders for positioning the stripper reel through a height range of 15 to 122 cm were supplied by the tractor hydraulic system.

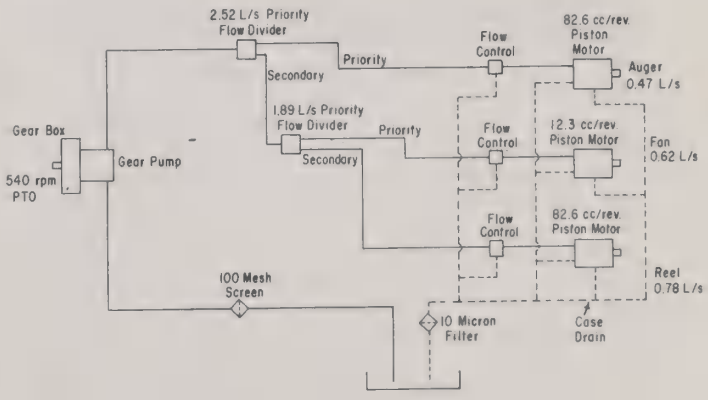


Figure 3.—Schematic of hydraulic circuit used to drive the harvester system.

Harvester Evaluation

Initial tests with the Oklahoma State University grass stripper operating on Caucasian bluestem revealed essentially the same results for the rubber fingers and the wire flails. Both were too aggressive and removed the plant stems with the seed. An additional problem was encountered with the wire in that continued operation resulted in fatigue and breakage. The rubber fingers and the wire were rejected as flail materials for this application.

Replicated tests were conducted with the stripper on Plains bluestem during the fall of 1977. Two forward velocities (2.7 and 3.9 km/hr) and two reel speeds (500 and 750 rpm) were evaluated for the 1.6 mm nylon flails. Three sample areas were harvested using the 3.2 mm nylon flails operating at 400 rpm and at forward speeds of 2.7, 3.9, and 5.9 km/hr.

The effects of reel rpm and forward speed on stripping efficiency are presented in figure 4. The percentage of seed removed by the 1.6 mm flails was dependent on both reel rpm and forward speed. Although only one reel rpm was used for the 3.2 mm flails, it is assumed that a similar relationship exists for them also.

The pure seed content of the harvested product was exceptionally high as compared with most conventional methods of harvesting chaffy seeded grasses. Straw content ranged from 4 to 11 percent, free grain from 3.2 to 5.5 percent, and pure seed from 29 to 45 percent. Moisture content of the seed was approximately 60 percent w.b. with bulk density of 138 kg/m^3. The immediate effects of this harvesting method on seed damage and germination are being evaluated and will be reported at a later date.

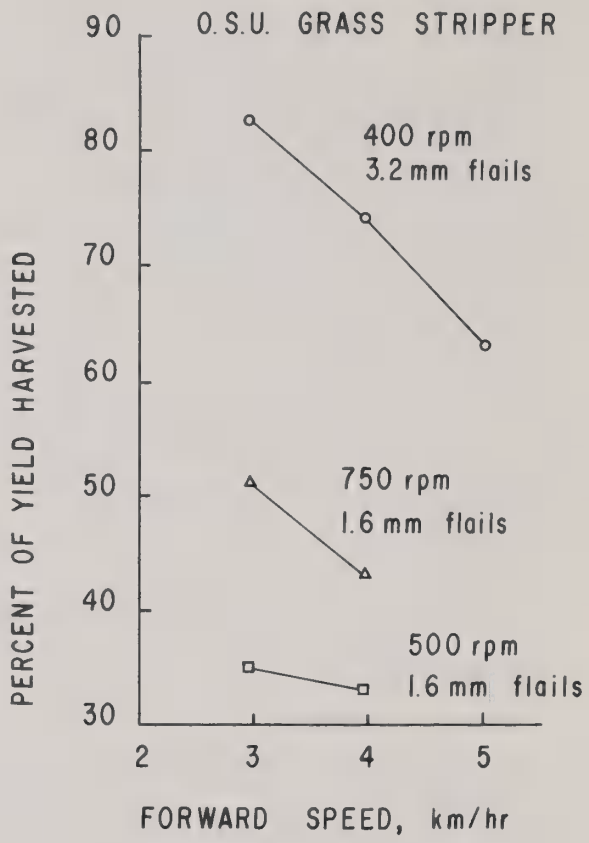


Figure 4.—Effects or reel rmp and forward speed on stripping efficiency.

Conclusions

1. Stripper reels with 3.2 mm flails performed superior to the 1.6 mm flails in that they removed a greater percentage of the seed at lower rpm yet did not adversely affect product quality.
2. Harvesting speeds of up to 5 km/hr are possible with the OSU stripper. This is approximately 1.2 ha/hr. for the 2.7 m header width of the stripper.
3. Aggressiveness of the stripper reel may be adjusted over a wide range by speed variation. This suggests the possibility of multiple harvests for indeterminate grass species.

Steep-Slope Stabilization

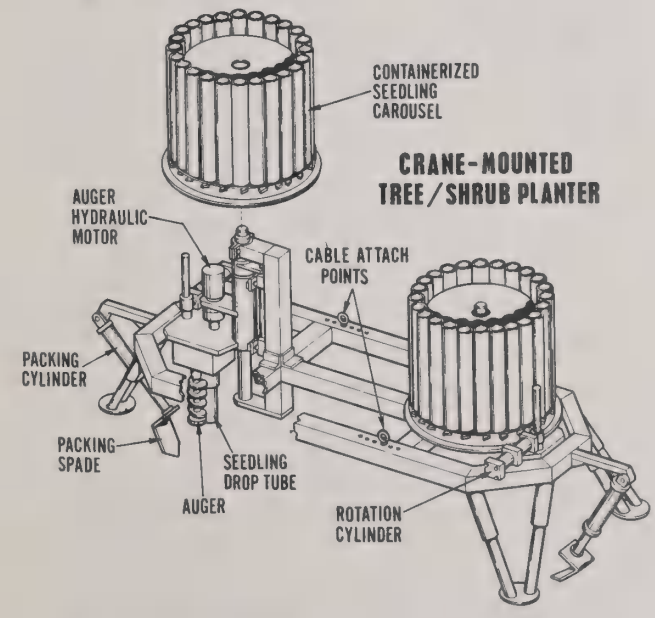
Lou Spink, *Chairman*

In October 1976 the prototype scarifier/seeder designed by the Forest Service San Dimas Equipment Development Center was tested on the Boise National Forest, Idaho. These tests were aimed at comparing the effectiveness of this new approach to planting roadside slopes with three current methods: broadcast seeding; hydroseeding with Silva fiber mulch; broadcast seeding with straw mulch held in place with jute netting.

Steve Monsen of the Intermountain Forest and Range Experiment Station has prepared a brief report on this test (see below). His results cover the 1977 growing season. All test sites were along one road near Idaho City, Idaho. The fill slopes were generally 1½:1; most of the cut banks were measured at ¾:1. The soil is coarse-textured granitic sands.

The cost of hydroseeding the test sites was estimated at $400 to $600 per acre. Broadcast seeding in Washington and Oregon averages $40 per acre. Broadcast seeding, straw mulching, and jute netting averages about $3,200 per acre in the same area. The cost of operating the scarifier/seeder on the Boise National Forest ran about $100 per acre, unless the amount of slash on the site caused difficulties for the operators, then costs were about $180 per acre.

Since the tests on the Boise National Forest, work has been aimed at making the scarifier/seeder more durable without increasing its weight beyond the capacity of existing hydraulic cranes. A crane-mounted automatic containerized tree/shrub planter is also under development.



Crane-mounted, automatic containerized tree/shrub planter.

In FY 1978 a project goal is to finalize the scarifier/seeder. This includes extensive tests of performance and reliability in the Pacific Northwest planned for this spring. Another goal is to continue development of the prototype automatic containerized planter, with testing of the unit also planned for this year.

Report of Field Trials with the Scarifier/Seeder

Presented by Stephen B. Monsen, Forest Service

In the fall of 1976 planting trials were conducted on the Boise National Forest to assess the seeding capabilities of the scarifier/seeder. The tests were made on a newly constructed logging road near Idaho City. The route had been built through granitic soils or parent materials. These soils are coarse-textured sands. Once exposed, the planting surfaces become loose and unstable.

Scarifier/seeder.

The machine was used to seed both cut and fill surfaces along a 1-mile section of the road. Approximately 2 acres were seeded. The sites were planted to a mixture of grasses, but seeds of ponderosa pine, snowbrush ceanothus, and western yarrow were also included (table 1). A granular form of fertilizer was also applied simultaneously with the seeding. The fertilizer was dispensed through a separate spreader and was not mixed with the seed. Approximately 100 pounds of fertilizer was applied per acre and about 30 pounds of seed.

Studies were established along fill slopes to compare the success attained by using (1) the scarifier/seeder, (2) broadcast seeding, (3) hydroseeding with Silva fiber mulch, and (4) broadcast seeding with straw mulch held in place with jute netting. In all trial plantings, permanent study plots were established to determine seedling emergence, survival, ground cover, and growth performance of the seeded species. The study plots were reinventoried throughout the germination period and growing season of 1977. This report includes the vegetative responses that were recorded.

Table 1.—*Seed mixture*

Species	*Lb/acre*
Brome, smooth (Manchar)	4
Brome, smooth (Lincoln)	4
Fescue, hard	2
Orchardgrass	2
Timothy	2
Wheatgrass, crested	4
Wheatgrass, intermediate	4
Wheatgrass, pubescent	4
Pine, ponderosa	1
Ceanothus, snowbrush	1
Yarrow, western	1
Total	29

Machine Operability

The seed and fertilizer dispensers operated very satisfactorily. The application rates were easily adjusted, and both seed and fertilizer were distributed uniformly over the seedbed. The amount of seed and fertilizer applied could be controlled to avoid waste. A variety of seeds were used; little or no separation was observed of the seeds within the seed can. No damage of dispensed seed was detected. The seed can holds enough seed to plant about 1½ acres. This did not cause serious delays in refilling the hoppers.

The machine was capable of planting over debris piles, stumps, rocks, and other large obstacles. Seeded plants were successfully established amid these sites. Using this machine, debris can be left in place to serve as a protective mulch for the young seedlings. These restrictions usually prevent other types of seeding equipment from being used. The machine does not compact the seedbed and could not be used to crimp or incorporate mulch into the soil. However, the drags do firm the soil surface and this reduces wind erosion. Some small sticks and pieces of litter were compressed into the soil. Large branches were left in place on the surface.

The machine is quite maneuverable and small areas were easily seeded. Few areas were encountered that were missed by the operator. On steep, erodible slopes, seeds were properly planted within the soil. The drags loosened the soil surface and covered the seed at a suitable depth. Seeds were not left on the surface to wash or blow away.

Plant establishment

Seedling counts were taken throughout the germination period. Mature plants also were counted at the end of the growing season. These counts were made on sites planted with the machine and with other methods of seeding. The average number of seedlings and mature plants recorded are reported in figure 1. Sites seeded using the machine produced more plants per square foot than any other treatment. Hydroseeding and broadcast planting resulted in approximately three and four plants per square foot respectively. In comparison, sites broadcast seeded and then covered with both a straw mulch and jute netting produced about six plants per square foot. Similar areas seeded with the scarifier/seeder supported eight plants per square foot. The counts were recorded on dry, exposed slopes having a south aspect. On more moist sites, machine plantings resulted in 11 to 28 plants per square foot.

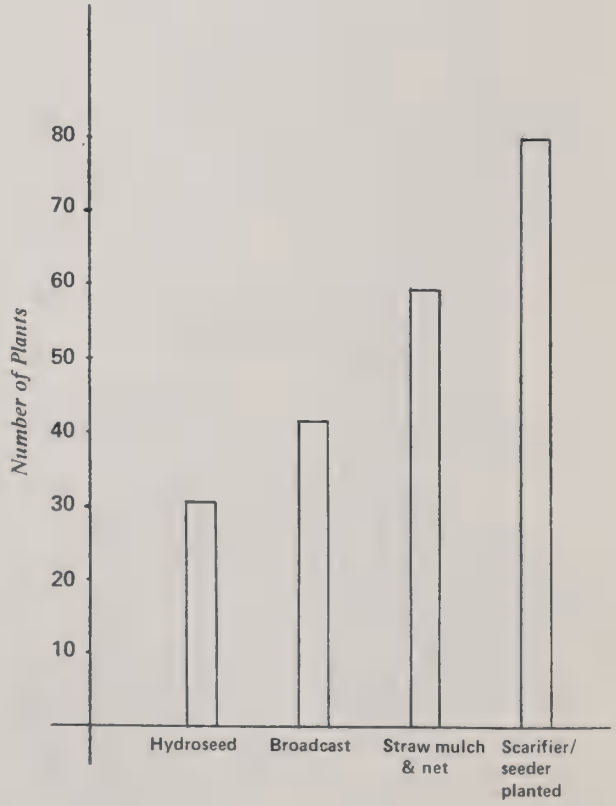


Figure 1.—Average number of plants per 9.6 sq ft plot.

Both machine planting and straw with jute net mulching provided a substantially better ground cover than achieved by broadcasting or hydroseeding (fig. 2). Both methods also provide a more uniform distribution of plants. Broadcast plantings and hydroseedings develop a stand only in areas where the soil surface is rough and seeds are worked into the soil. By contrast, the scarifier/seeder created a good planting surface in all areas, particularly important on steep exposures. The increased number of plants obtained by this machine is encouraging. Although hydroseeding or broadcast planting usually results in the establishment of some plants, the success is almost nil on the more harsh sites. The scarifier/seeder achieved good success on the more difficult areas. It achieved three important accomplishments over other methods of planting: (1) an increased number of seeded plants; (2) plants became established in nearly all seeded areas, including harsh steep slopes; and (3) a much better distribution of plants.

The percent ground cover attended by different planting methods depended on the number of seedlings established. In all tests, sites machine planted achieved a higher ground cover than other treatments. Usually fill slopes develop only about 30 percent ground cover the first year. Any improvement over this figure is a substantial accomplishment and greatly aids in achieving better surface stability. Broadcast plantings, with and without mulch, created an irregular vegetative cover. This is particularly true if the slope is only broadcast planted. Large openings and weak spots often occur in these sites. Plantings using the scarifier/seeder did not exhibit these bare sites. Seeds planted with this machine remained in place over winter, germinated, and attained a uniform and adequate ground cover.

Various alternatives must be considered in selecting the methods of roadway planting. However, the scarifier/seeder appears to offer a useful means of establishing plants on steep, erodible soils. The machine performed adequately and provided a better ground cover than the other conventional methods of seeding used.

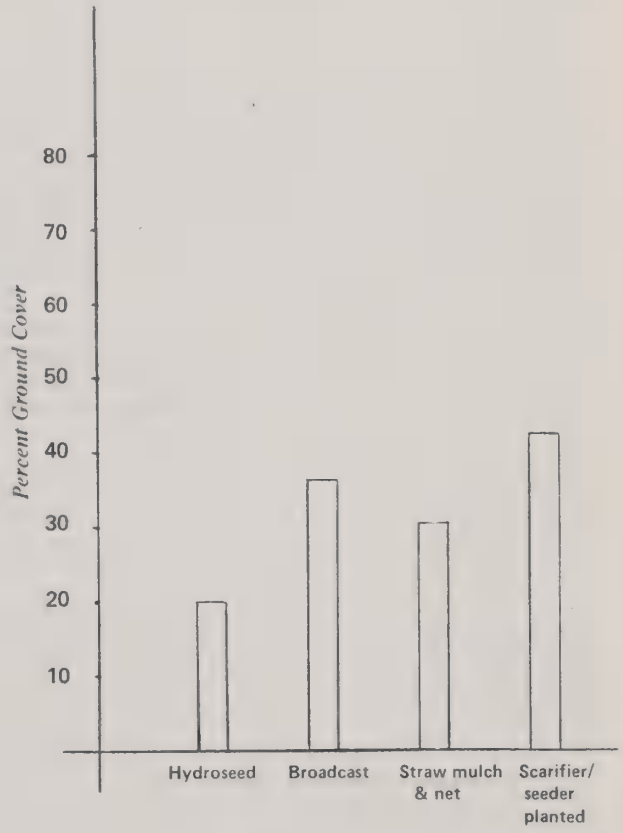


Figure 2.—Percent plant cover attained by different methods of planting.

Disturbed Land Reclamation
(Eastern "Sub" Group)

Willis Vogel, *Co-Chairman*

Disturbed Land Reclamation and Environmental Problems on Eastern Ecosystems

Presented By Don Mellgren, Fish and Wildlife Service

Introduction

Historically, the Vegetative Rehabilitation and Equipment Workshop (formerly the Range Seeding Equipment Committee) has concentrated its efforts on solving problems dealing with the rehabilitation of rangelands of the western ecosystems. In the last 2 to 3 years, our attention has focused more and more on land disturbance specifically resulting from mineral extraction. This is a logical approach since I personally don't think it makes any difference whether surface disturbance is the result of overgrazing, fire, mining, or other causes. Each contributes adverse impacts upon the environment which should be corrected effectively, efficiently, and economically.

The thrust to attain energy independence and at the same time reduce our consumption of oil and gas, has placed coal at the top of the list as an energy source. For this reason, the eastern ecosystems cannot be ignored. Coal has been "King," particularly in the Appalachian Region, since the 1800's. The pre-law mining activities have taken their toll on the land and resulted in tremendous acreages of orphaned or abandoned mined lands.

It has been estimated that in excess of 3 million acres of abandoned mined lands exist in the states east of the 100th meridian. Of this total, the Soil Conservation Service has determined that approximately 70 percent are either nonproductive or producing below their potential. These lands are contributing to adverse environmental impacts in that they are a threat to health and safety due to the existence of highwalls, contaminated water, acid mine drainage, precipitates, and sediment. They also provide a medium for the propagation of undesirable vegetation.

On the plus side, these lands have shown tremendous potential for recovery, both naturally and by application of proper reclamation prescriptions. They respond readily to treatment and are also a reservoir for the collection of technical data on plant-soils relationships, plant succession, etc.

Narrative

This introduction was followed by a slide presentation which depicted the various types of mining activities and the problems that arise therefrom. Monitoring and enforcement of regulations are a monumental task. In the four coal producing states represented in Region 5, there are 3,710 active mines. An average rule of thumb in the eastern ecosystems is that for every surface acre of coal removed, four acres are disturbed.

All of the coal states in the east have reclamation statutes of some kind or another. In reviewing these statutes, we have found that they are either void or lacking in requirements for the replacement of fish and wildlife resources. Most of the land is privately owned. Many of the land owners and mining operators are interested in protecting, restoring, and enhancing these values, but there is a lack of expertise to provide them with guidance when they need it. There is also a need to greatly improve on information transfer among agencies and the mining industry.

Specific Problem Recommendations

1. Two years ago, the Kentucky Reclamation Association borrowed two rangeland drills from the Bureau of Land Management to see if they were adaptable to eastern disturbed lands. They were so successful that KRA purchased its own. These new drills have proven to be disappointing. Structural defects, breakage, etc., has resulted in maintenance costs that exceed the initial cost of the drills. We recommend that the Seeding and Planting Workgroup investigate these failures and determine the cause.

2. We are in need of a machine that can be operated on steep slopes that will scarify, seed or add fertilizer or lime.

Disturbed Land Reclamation (Western "Sub" Group)

Don Calhoun, *Co-Chairman*

Several significant equipment projects related to mined land reclamation have been worked on this year, and some are essentially completed. But a lot remains to be done. The details of these equipment discussions will be left to the several committee members who will make presentations. I am proud to be associated with this Committee and grateful for the effort put forth by several members who can visualize the needs that exist and are willing to devote time toward making some of these visions materialize.

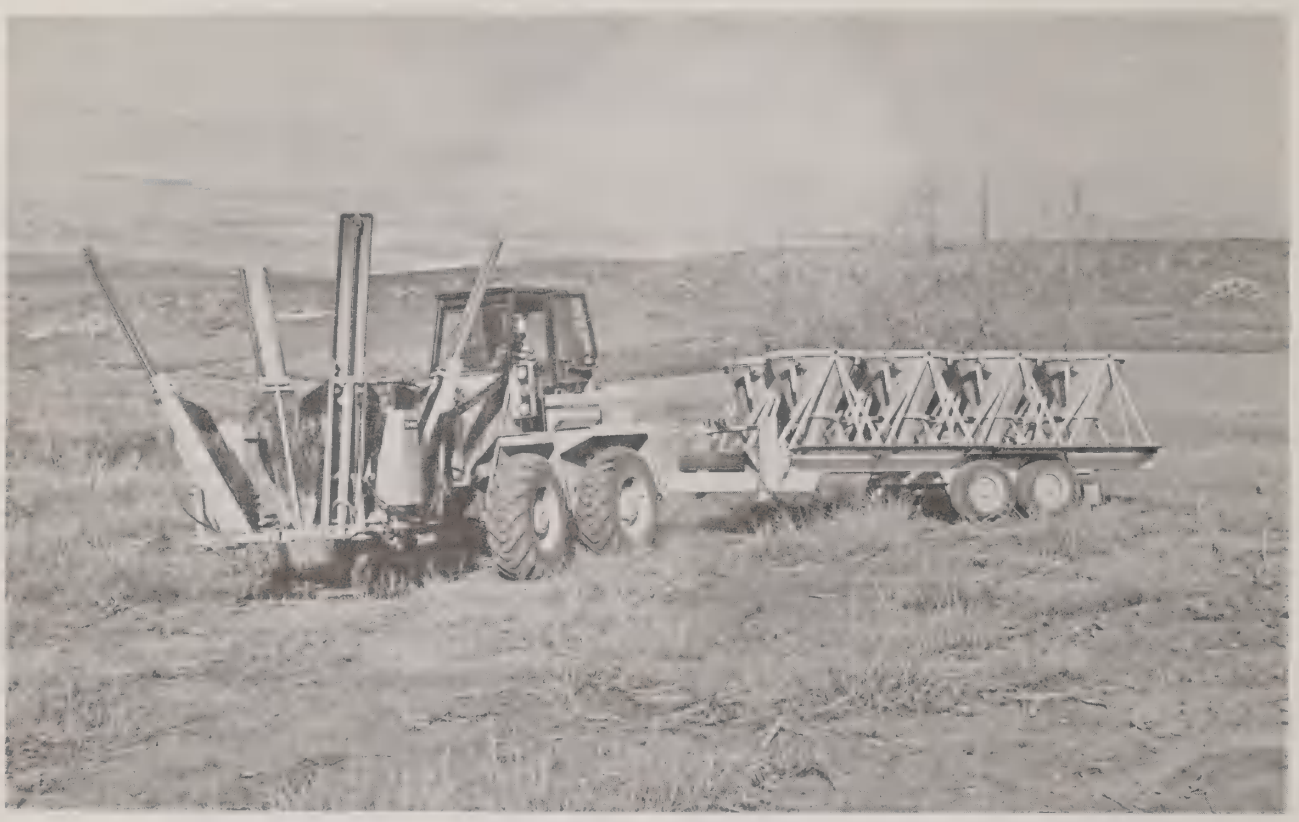
Soil Conditioner (ED&T 2629)

Problem. A major problem land managers face when attempting to revegetate mined over land, especially in semiarid parts of the West, is the condition of the soil. Even if the topsoil is saved, the soil structure has been destroyed and cultural work must be done primarily in parent soil material. In areas where this problem exists, soil conditioning should be done to enhance the revegetation effort.

Goal. The goal is to make available to land managers the equipment needed to condition soil for disturbed land rehabilitation.

Work Accomplished to Date. The Forest Service Missoula Equipment Development Center (MEDC) purchased a 100-inch Howard Rotavator and evaluated it as a soil conditioner on a BLM test site near Rawlins, Wyo., in FY 1976. It was used to test the concept of conditioning soil by mixing in about 2½ tons of hay per acre. Local Bureau of Land Management personnel are following the results of that test. Later in FY 1976, MEDC personnel assembled a "library" of information pertaining to components and other equipment useful in selecting parts for a new prototype soil conditioner-mulcher. Four alternative configurations for a tiller-mulcher system were evaluated. The system selected for development uses the rotovation and mulch spreader as separate machines each to be powered by a farm tractor. The mulcher is the largest commercial manure spreader, modified to spread hay at the 2½-ton-per-acre rate. Tests of the system were conducted at Colstrip, Mont. In FY 1978 the equipment was further tested in Wyoming with straw and at Colstrip with sludge. This work completed the testing. The project will be completed with the publication of a final report, drawings and specifications, and operator and maintenance manuals. The equipment is being turned over to the BLM for its use.

Rotavator (background) and mulch spreader combine to improve growing conditions on reclaimed mine site.



Equipment for transplanting trees and shrubs on reclaimed mine sites.

Transplanter (ED&T 2630)

Problem. Achieving good planting survival on disturbed lands can be especially difficult because of the loss of the A and B soil horizon levels. If the original topsoil is not replaced, planting is done in parent materials. One- or 2-year-old bareroot stock may not be hardy enough to survive in this type of soil. The problem is developing equipment and techniques that allows use of local native transplant material, which can survive on harsh, disturbed areas.

Goal. The goal is to make available to people engaged in land rehabilitation, equipment to aid in transplanting material for revegetation of disturbed lands.

Work Accomplished to Date. A hydraulically operated tree transplanting machine has been developed for the ornamental landscape industry. It employs a principle that should be applicable to this problem. With this machine, it is possible to remove trees up to about 6 inches in diameter with the roots retained in a ball of an appropriate size to insure survival. The machine comes in a variety of sizes and can be trailer mounted or attached to tractors or other vehicles. In FY 1976 MEDC purchased a hydraulic tree transplanting machine. A series of tests were done on mine spoils in Montana and Colorado. Various tree and shrub species were transplanted on reclaimed sites. The equipment was evaluated and improvements for revegetation work were suggested. A report documenting the tests was published. During FY 1977 a system using a self-propelled transplanter and trailer to haul eight trees was fabricated and tested. In FY 1978 the transplanter was further tested and Bureau of Land Management operators trained in its use. A report, drawings, and specifications will be completed to end the project.

Basin Blade (ED&T 8041)

Problem. On the semiarid ranges of the Western United States, various methods are being used to make depressions in the soil to trap moisture and to create a more favorable microclimate for vegetation. Depending on the specific needs, depression size can vary from small pits to large dozer blade scalps. On slopes up to 10 percent, where depression sizes can be fairly small and shallow and still work effectively, equipment choices are many but on slopes above 10 percent, equipment options are restricted. Dozer blades and plows are most commonly used. There is a need to develop equipment specifically designed to build larger depressions-basins on slopes above 10 percent.

Goal. The goal is to make available to personnel working in land rehabilitation, a basin-building machine to help stabilize and revegetate steeper slopes.

Work Accomplished to Date. Dr. Richard Hodder, agricultural extension agent, Montana State University, has developed a prototype basin blade towed by a D-8 or D-9 size dozer. The Hodder Basin Blade is capable of creating "bathtub" size depressions on slopes up to about 45 percent. The basin blade is raised and lowered by the operator,who can vary basin length, width, and depth. However, the prototype model cannot be tilted to permit the operator to build basins in either direction as he contours the slope. He must "deadhead" one way, which requires twice as much time to cover an area. The results of several years of testing the basin blade indicate that it is an effective rehabilitation tool, but design changes must be made to improve the unit's production rate.

Future Work. In FY 1978 MEDC project objectives are to test the Hodder Basin Blade to determine what design changes are needed, and then design and build a prototype of an improved blade and test it at a site selected by the Bureau of Land Management. The fiscal year's work will be documented in a report and reviewed with the EMRIA (Energy Mineral Rehabilitation Inventory and Analysis Program) staff as a basis for planning the completion of the project in FY 1979.

Dryland Tubeling Planter (ED&T 8042)

Problem. Planting of bareroot trees and shrubs on reclaimed strip mined land in the Western United States has generally not been very successful. In the process of transplanting bareroot stock, most of the fiberous roots are destroyed, which reduces the plant's ability to take up moisture from the soil after planting. The problem is further complicated when a plant with a weakened root system is planted on reclaimed land where summer drought and heat can severely stress even an established plant.

Goal. The goal is to make equipment available to personnel working in disturbed land rehabilitation that will enable them to successfully establish trees and shrubs on reclaimed sites typically subjected to harsh growing conditions.

Work Accomplished to Date. In the forest nursery industry, a dramatic new way of growing and planting tree seedlings is taking place. Seeds are sown in individual cavities that can vary in size from about 2 cubic inches to about 80 cubic inches. When ready, the plant is removed from the container and planted as a plug. The entire root system, with soil mix intact, is planted and the seedling's chance of survival is much improved. The forest industry in this country is now producing about 50 million containerized seedlings a year. Personnel in mine land revegetation are beginning to experiment with plug planting in the West. Early results indicate that containerized stock, properly used, can speed up revegetation and reduce cost because of better survival. To date, however, all plug planting on reclaimed land has been done by hand. In the case of containerized forest tree seedlings, a number of prototype automated plug planters are being developed. These machines will be capable of high production rate planting of small (2 to 10 cubic inch) containerized seedlings. But to our knowledge, no equipment is available for machine planting of the large (40 to 80 cubic inch) containerized stock needed for disturbed land revegetation.

Future Work. In FY 1978 MEDC will meet with Bureau of Land Management personnel to establish criteria for the design of a dryland plug planter. A market and literature search will be conducted to determine the state-of-the-art in planting machines for planting plugs. When all the information has been gathered and evaluated, a prototype dryland planter will be designed. The design will be reviewed with the EMRIA (Energy Mineral Rehabilitation Inventory and Analysis Program) staff and plans for FY 1979 will be made.

Dryland Sodder (ED&T 8046)

Problem. One of the land manager's greatest concerns in rehabilitating strip mined land is topsoil replacement on reshaped spoil material. Present topsoil handling methods destroy the structure of the material and its vegetative cover. Topsoil has definite gradients of organic matter, nutrients, and micro-organisms. When the topsoil is stripped off to be piled and stored for later use, thousands of years of development are lost. Preserving the topsoil with its structure and vegetative cover intact would be a tremendous advance in reclaiming strip mined lands.

Goal. The goal is to help make available to land managers responsible for administering lands undergoing surface mining a method of moving topsoil while preserving its structure and vegetative cover.

Work Accomplished to Date. The Bureau of Mines has contracted with Dames & Moore, environmental consultants, Denver, Colo., to investigate the problem and propose concepts for developing topsoil moving equipment. At the request of the Bureau of Mines, Don Calhoun, Bureau of Land Management, Denver, is participating to offer advice. At a meeting with BLM personnel in Denver to discuss equipment needs for rehabilitation, Calhoun stated the Bureau of Mines effort appears to be aimed at large-scale equipment, the kind of equipment only large operations could afford. For that reason, Calhoun believes a need exists for a development project to solve the topsoil moving problems on the average size operation with equipment the average operation could afford to purchase.

Future Work. In FY 1978 MEDC will meet with BLM personnel to determine the requirements for a dryland sodder. The work of the Bureau of Mines will continue to be monitored. A market and literature search will be conducted to determine what equipment or concepts might be used. Concept drawings for a dryland sodder will be prepared and reviewed with the EMRIA (Energy Mineral Rehabilitation Inventory and Analysis Program) staff. Plans for future work will be discussed.

Thermal Plant Control

Bill Davis, *Chairman*

Thermal Brush Control (ED&T 2168)

No field testing of the propane burner was made in 1977. All planned prescribed burning projects were cancelled due to drought conditions and shortage of forage for permitted livestock.

The Forest Service Missoula Equipment Development Center conducted a study using photographic methods to determine heat distribution of each of the four burners. These tests were related to height of the burners and speed of travel.

The Uinta National Forest in Utah made several minor modifications to the burner. A new hydraulic control valve was installed to facilitate adjusting fan speeds by the operator. New mounting brackets for the burners were installed to facilitate 90-degree rotation of the burners.

Planned testing in 1978 entails additional fireline preparation on the Uinta National Forest and dormant season burning on the Caribou National Forest, Idaho. Utah State University personnel are planning to use the burner to simulate prescribed fire in their study of the black grass bug *(Labops hesperitus Uhler).*

Recommendations

1. Continue to use and test the present burner.

2. Construct a new two-blower burner along similar concept of the present model. The new model should be made much lighter in weight, using 3,000 pounds as a guide. Present model weighs over 6,000 pounds. The undercarriage should have tandem axles with springs and walking beam as used on light camp trailers. All four wheels should have hydraulic brakes actuated by a "surge brake" hitch with disabling provisions. Axles should be high clearance type (not drop center) and wheels should be at least 16-inch rim size.

Aerial Burning Equipment for Plant Control (ED&T 2627)

Problem. Of all plant control methods used on Western rangelands, burning is usually the most economical, even if repeated burning is required. Perhaps the biggest drawbacks to prescribed burning on rangeland are the dangers of wildfire and the difficulty of getting a clean burn. Improved techniques and equipment are needed to insure that burning of undesirable plant species can be done safely and effectively.

Goal. The goal is to make available to the rangeland manager equipment needed to improve prescribed burning techniques with greater safety and less risk of wildfire.

Work Accomplished to Date. The Forest Service Missoula Equipment Development Center has done much work with aerial firing systems for fire management. Much of the use has been on wildfires, but the system has also been used to burn slash and browse for big game habitat improvement in Idaho. In reviewing this system for rangeland burning, there was a feeling that the military thermate grenade now being used produces more heat than is needed to ignite fine fuels and is too expensive for the multi-point ignition needed for rangeland burning. A search for a more economical incendiary has been conducted, and there appear to be at least two options available, both developed in Canada: One aerial system, known as the "flying drip torch," has been used to burn slash on the west coast by the Weyerhaeuser Co. and on a limited basis by the Gifford Pinchot National Forest in Washington. The other system is a dispenser for dropping a "Ping-pong" ball incendiary. In FY 1977 that incendiary system was fabricated in the MEDC shop and demonstrated locally. In FY 1978 field tests will be conducted in Idaho and a report written to conclude the project.

Brush Control with Electric Current

Lasco, Inc., Vicksburg, Miss., markets a device that kills weeds and plants by electric discharge. This electric discharge system (EDS) may have application in the control of undesirable brush from rangeland. One version of the EDS is mounted on a four-wheel-drive vehicle and is reported to have a production rate of over 7 acres per hour. Hugh A. Warren III, director of agricultural operations for Lasco, presented a slide program to the Workshop about the electric discharge system.

Introduction to Electrical Plant Control
Presented by Hugh A. Warren III, Lasco, Inc.

Four-wheel-drive, articulated logging skidder carries a 200-kilowatt electric discharge system for killing weeds and plants.

This past summer, Lasco entered into a cooperative contract with the Bureau of Reclamation, Rio Grande Project, El Paso, Tex., for the experimental evaluation of the effectiveness of the EDS in controlling selected weed species. The preliminary visual results were of a good top desiccation to ground level of plants such as saltcedar and seepwillow but still having regrowth capabilities. A final evaluation will be made this coming spring to determine the extent of regrowth of treated plants.

The EDS equipment is basically a power package to produce and control the necessary electrical energy, and a variety of applicators to deliver the energy to the plants. Selectivity is achieved primarily on the basis of plant location or geometry. For example, plants located between rows in row crops, and tall overhead weeds in most any situation can be effectively killed with the EDS. It is also possible to achieve a certain degree of selectivity based on the variation of plants abilities to tolerate the dissipation of electrical energy.

EDS kills on contact by forcing the electrolytic solution within the plant's vascular system to conduct electrical current. The electrical energy dissipated within the conducting solution manifests a very rapid temperature rise and expansion into the vapor phase. The resulting thermal and physical stresses rupture cell walls and break down the plant's vascular system. Most annuals are destroyed with perennials being top killed.

The EDS effectively and economically kills broadleaf weeds, grasses, small trees, and brush on contact. In most applications where EDS can compete with chemicals for effectiveness, it has a direct economic advantage plus many indirect advantages. There are obvious environmental advantages in using clean electrical energy to kill plants as opposed to chemical herbicides. It also reduces soil erosion when compared to mechanical cultivation and reduces vulnerability to adverse field and weather conditions when compared to chemical herbicides.

The operational versions of EDS equipment are as follows:

- *EDS Cultivator.* The EDS Cultivator combines mechanical cultivation with EDS techniques for treating weeds in the row or drill area that cannot be reached with the Cultivator tools. The EDS probes are adjusted to pass just over the top of the crop and/or just outside the drill area. Most weed species from 3 to 12 inches in height are killed on contact with the probes. The unit requires, at maximum power, 40 horsepower from a 540 rpm PTO drive, to treat six or eight rows.

- *Lightning IV.* The Lightning IV is attached to a farm tractor of at least 100 horsepower with a 1,000 rpm PTO drive. Several safety interlocks are incorporated that must be satisfied to energize the applicator. The safety interlocks sense integrity of electrical ground connection, forward motion, and operator position. While in operation, should the machine lose its electrical ground, stop forward motion, or the operator fall from his seat, the interlocks would detect any of these unsafe conditions and shut down the high voltage. These patented safety features, along with operator training and supervision, insure safety for both operators and bystanders.

- *RT 200.* This four-wheel-drive, articulated, rough-terrain unit is self contained and produces an electrical output of 200 kilowatts. It is effective for treating broadleaf weeds, brush, trees, etc., to heights of 15 feet in flood plains, rangeland, right-of-way, and other noncrop areas.

For more details, write to:

Lasco, Inc.
P.O. Box 187
Vicksburg, Miss. 39180

Mechanical Plant Control

Carl M. Rice, *Chairman*

Mechanical Equipment for Brush Cutting and Slash Treatment

The Forest Service San Dimas Equipment Development Center is preparing a publication containing all currently available information on mechanical brush cutting and slash treatment equipment; tables are included summarizing information obtained from field projects. Information was collected from 12 sources that produce or have offered 23 different models of heavy-duty brush cutters and slash treatment equipment. All the listed equipment (see paragraphs that follow), except the Nicolas and Royer, has self-propelled integral prime movers. The two exceptions attach to standard prime movers (such as track or wheel loaders, dozers, and farm tractors) and have had some use in thinning and slash treatment work on National Forests.

Bennington Tractor Co.
706 Alpha Dr.
Cleveland, Ohio 44143
(216) 449-5816

Bennington has designed and built a horizontal-shaft shredder head with free-swinging blades mounted on a Caterpillar 955 crawler loader undercarriage and powered by a single 210-horsepower engine.

Bombardier, Ltd.
Valcourt, Quebec, Canada J0E 2L0

Bombardier produces a low ground pressure brush cutter with two vertical-shaft cutters powered by a single 130-horsepower engine.

Kershaw Manufacturing Co.
P.O. Box 9328
Montgomery, Ala. 36108
(205) 263-5581

Kershaw has produced four models of its Kershaw Klearway (10-3, 10-5, 10-6, and 10-7), all having large rubber tires and two vertical-shaft cutters with free-swinging blades driven by a single 123-horsepower engine for the 10-3 and 10-5 and a 188-horsepower engine for the 10-6 and 10-7.

National Hydro-Ax, Inc.
P.O. Box 568
Owatonna, Minn. 55060
(507) 451-8654

National Hydro-Ax has produced four models of the Hydro-Ax (300, 500, 700, and 1000); all have large rubber tires and a single vertical-shaft cutter with free-swinging blades. Models are powered by single 91-, 117-, 175-, and 262-horsepower engines, respectively.

NFI, Inc.
304 Willow Glen River Rd.
Alexandria, La. 71301
(318) 487-8371

NFI has designed and produced a large rubber-tired, horizontal-shaft shredder with fixed teeth powered by a single 600-horsepower engine.

Nicolas
89290 Champs-sov-yonne France

Nicolas of France has marketed in the United States three models of its horizontal-shaft mulching machines with free-swinging flails.

Pettibone Corp.
Alabama Division
Greenville, Ala. 36037
(205) 382-3183

Pettibone Alabama Division is now marketing a compact brush cutter with rubber tires and two vertical-shaft cutters having free-swinging blades powered by a single 123-horsepower engine.

Pettibone Michigan Corp.
P.O. Box 368
Barage, Mich. 49908
(906) 353-6611

Pettibone Michigan Corp. is producing a vertical-shaft, free-swinging blade, wheeled brush cutter powered by a single 180-horsepower engine. This firm also designs and builds a horizontal-shaft (with free-swinging blades) forest residues reduction machine powered by a single 262-horsepower engine.

Royer Foundry & Machine Co.
158 Pringle St.
Kingston, Pa. 18704
(714) 287-9624

Royer manufactures three models of a shredder called the Woodsman, formerly offered as the Shred King by Triumph Machinery Co. All models are horizontal-shaft machines with free-swinging cutter blades. One model is self-powered by a 117-horsepower engine designed to be carried by a crawler tractor or end loader. One model is designed to be carried and powered by a Case Unimog; the third is designed to be carried and powered through a PTO by a tractor with a three-point hitch.

Forest Service, USDA
Equipment Development Center
444 East Bonita Ave.
San Dimas, Calif. 91773
(213) 332-6231

The San Dimas Equipment Development Center designed and had fabricated under contract a forestland residues reduction head. The head has been mounted on a Hydro-Ax 1000 and is now being field tested.

Shredco
P.O. Box 852
Clermont, Fla. 32711
(904) 394-5491

Shredco has designed, fabricated, and is operating an experimental horizontal-shaft, fixed-tooth, rubber-tired machine for shredding citrus trees.

Washington Industrial Resources, Inc.
12514 Pacific Highway South
Seattle, Wash. 98168
(206) 244-9510

Washington Industrial Resources manufactures and markets a machine called the Timbermaster TM-72, formerly known as the Trakmac TM-72 when manufactured by Washington Iron Works. The Timbermaster is a four-tracked, articulated machine with a cutting wheel mounted on a swinging boom which cuts a 12-foot swath.

Chaparral Meeting

A "Chaparral for Energy Information Exchange" meeting was held on the Angeles National Forest, Pasadena, Calif., in July 1976. Proceedings of this meeting are now available in limited numbers from Bob Reese, Angeles N.F. or from the Forest Service Pacific Southwest Forest and Range Experiment Station at Glendora, Calif.

Machine to Harvest Slash, Brush, and Thinnings for Fuel and Fiber

The Forest Service Southern Forest Experiment Station, Pineville, La., in cooperation with the Energy Research and Development Administration and five Southern pulp and paper companies, has under contract the development of a machine to harvest slash, brush, and thinnings for both fuel and fiber. A breadboard model of the cutter head and chipper has been tested and plans are to complete and field test the machine this summer.

Symposium—Complete-Tree Utilization of Southern Pine

The Mid-South Section of the Forest Products Research Society, the Southern Forest Experiment Station, and the International Union of Forestry Research Organizations are sponsored a symposium on "Complete-Tree Utilization of Southern Pine." It took place in New Orleans, La., April 17-19, 1978. Papers were presented on the Southern Forest Experiment Station machine to harvest slash, brush, and thinnings for fuel and fiber. A number of other papers also will be presented. Symposium proceedings were/are available from the Forest Products Research Society, 2801 Marshall Ct. Madison, Wis. 53705.

Chemical Plant Control

Ray Dalen, *Chairman*

Aerial spraying of herbicides on rangelands has been done for many years using a wide variety of equipment and materials. Although today's greater concern with environmental safety has focused attention on all spraying projects, it appears that aerial spraying will continue to be a widely used tool in range management.

On many projects aerial application is the most practical technique. But the principles of aerial application of herbicides under wildland conditions are not always fully understood by all field people. Spray drift off the target area, which may result in reduced effectiveness and environmental damage on adjacent areas, is a primary concern. There has been a great deal of research and development directed toward finding practical ways to reduce drift. However, much of the information is not in a form useful and available to field people.

To solve this problem, a contract was awarded to Norman B. Akesson, University of California at Davis, to prepare a handbook to help field people who plan and supervise aerial herbicide application projects. The handbook covers project operations and safety, application equipment, meteorology, principles of drift control, selecting a spray drop spectrum, assessing spray patterns, as well as other topics. A review draft will be completed this summer, with publication scheduled for the end of 1978.

Technical Standards

Don Mellgren, *Chairman*

The Technical Standards Workgroup was established last year at the annual meeting in Portland, Oreg. Its creation was prompted by the following proposal:

> That the Vegetative Rehabilitation and Equipment Workshop consider sponsorship for the certification of all educational institutions west of the 100th meridian engaged in Reclamation Technology Programs.

Background and Rationale

This proposal was prompted by the fact that in the past 2 to 3 years, various educational institutions throughout the United States have established reclamation technology programs. These rec tech courses are generally of 2 years' duration, and the student is issued a certificate identifying him as a reclamation technician. Sponsorship for these rec tech programs is nonexistent now. As a result, no guidelines or minimum standards for instructors, curriculum, or facilities have been developed. This lack of standardization has resulted in considerable diversity in the quality of talent graduating from these programs. It is the opinion of this Workgroup that there are less complications if the individual receives proper training in the classroom rather than learning the hard way on the ground.

Sponsorship Requirements

Should the VREW accept the responsibility for sponsorship, the requirements are as follows:

Step I Develop minimum standards and procedures for accreditation of rec tech faculty, curriculum, and training facilities.

Step II Submit letter of intent, accompanied by copies of the minimum standards and procedures to the Director of Education for endorsement by Health, Education and Welfare, Washington, D.C.

Step III Notify educational institutions that VREW is sponsor for certification of accreditation for rec tech programs.

The Workgroup has prepared for review minimum standards for surface mine reclamation technician training programs and a section of procedures for accrediting a surface mine reclamation technology program:

Minimum Standards for Surface Mine Reclamation Technician Training Programs

Objective: *To produce graduates with the skills necessary to reclaim surface mined lands.*

1. The reclamation technician programs shall be established and operated only after adequate funding for faculty, facilities, equipment, and operation is assured on a continuing basis.

2. The reclamation technician programs shall be established and operated in association with an advisory council. Council members shall be experienced or knowledgeable in surface mining, surface mine reclamation, or education.

3. The reclamation technician programs shall be established and operated only after documentation has been made of the need for reclamation technicians in the area served by the program.

4. A high school diploma or its equivalent, as required by each school, shall be necessary for admission to the program. Retention and graduation standards shall be equal to those of the other technician programs of the school.

5. All reclamation courses taught in reclamation programs shall be taught by individuals with professional degrees in the environmental-related or engineering sciences who have basic knowledge of surface mine reclamation. The director of the program shall also have these qualifications.

6. The reclamation technician program shall offer a minimum training of 800 contact hours of technical reclamation instruction in addition to the general education requirements.

7. An associate degree shall be awarded to graduates of the program.

8. The reclamation technician faculty shall consist of at least two full-time instructors. The student to instructor ratio for classes allowing student participation shall be a maximum of 30 to 1. The maximum ratio for field instruction shall be 20 to 1.

9. The reclamation technician program shall have access and use of reclamation equipment and reasonable acreages of active and inactive surface mines suitable for training purposes.

10. The reclamation technician program shall require that each student participate in at least one of two options.

Option 1: The student shall work in the field with a reclamation program for 3 months between the first and second years of instruction.

Option 2: The student shall participate in a field tour of not less than 2 weeks. This tour will consist of field studies in as many diverse applications of reclamation as possible.

11. The reclamation technician curriculum shall contain an appropriate combination of course instruction in order to advance the basic educational level of the student. Instruction shall include an appropriate combination of formal class and field instruction which addresses regionally directed knowledge of the principles, planning, and practices of disturbed land reclamation.

Procedure for Accrediting a Surface Mine Reclamation Technology Program

Eligibility requirements for accreditation:

1. The objectives of the program must be clearly defined and stated in a comprehensive manner.

2. The program must culminate in an associate degree in surface mine reclamation technology.

3. The program must meet the minimum standards set forth for the associate degree in surface mine reclamation technology.

4. The institution offering the surface mine reclamation technology program must be accredited by its regional accrediting association.

When to apply for accreditation examination:

Application for accreditation examination must be made at least 6 months before the beginning of the school year in which accreditation examination is desired.

How to apply for accreditation examination:

The director of the reclamation technology program and head of the institution write to the accreditation chairman of the Council for Surface Mining and Reclamation Research in Appalachia and state that they desire an accreditation examination. The institution officials should also send six copies of any descriptive literature that can be used by the accreditation committee to evaluate the school program. In particular, the committee needs to know the number of faculty involved in the reclamation program, the education level of the faculty, and physical facilities of the school, mining areas available for laboratory study, course syllabuses, records of financial commitment to the program, faculty workloads, and degree of faculty participation in surface mine reclamation activities.

Accreditation Examination Procedure:

If the application is approved, the accreditation committee schedules a 2-day, on-campus visit.

The committee chairman advises the institution head of the details of the visit. These details may include faculty examinations, equipment examinations, student interviews, alumni interviews, and employer consultations. The committee chairman then appoints an accreditation team for the on-campus visit.

The accreditation team meets as a group before leaving the institution and members assure themselves that they have all information necessary to make the accreditation decision. If they need further information, they are to acquire such information before leaving the institution.

The accreditation team notifies the institution head and program director of its accreditation finding within 2 months after the accreditation visit.

If the program is not accredited, the committee notifies the institution head and program director of the reasons for denying accreditation. The institution head and program director are then invited to refute the committee's findings at a formal hearing before the full accreditation committee.

If the full committee upholds the accreditation team's findings, the institution can request another examination 2 years after the initial examination. If the full committee finds the accreditation team to be in error, they may accredit the program.

Reexamination:

Each reclamation program will be reexamined for accreditation at 4-year intervals after the first accreditation is bestowed. However, the council may call for a reexamination at any time it has reason to believe that a reclamation technology program has fallen below minimum standards.

Equipment Parts Facilities

Frank Winer, *Chairman*

Final Report

The Forest Service Stockton Equipment and Service Depot, Stockton, Calif., closed in September 1977. The remaining repair parts for the rangeland drill, brushland plow, and contour furrower were transferred to the BLM Vale District, Vale, Oreg. Other possible parts sources could be commercial firms or past drill, plow, and furrower fabrication contractors. Laird Welding & Manufacturing Works, Merced, Calif., is an active fabrication contractor of drills, plows, and furrowers. And this firm is able to supply most repair parts for this equipment.

Papers

Land Imprinting

Gary Frasier, *Science and Education Administration*

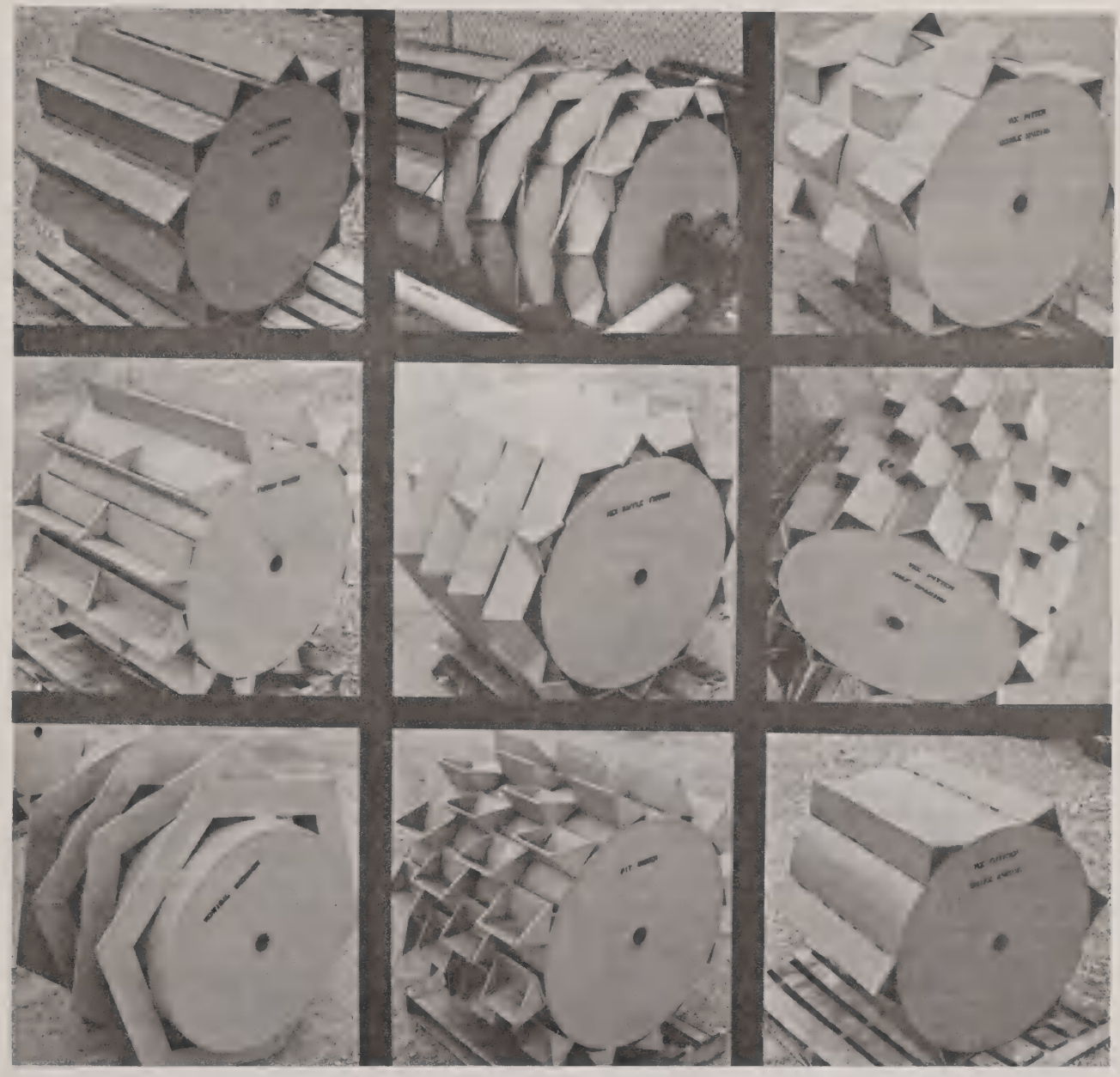
Theoretical Basis

Design of the land imprinter is based on a new concept for controlling rainwater infiltration referred to as the air-earth interface (AEI) concept. The AEI concept indicates that water infiltration is controlled by the microroughness and macroporosity of the soil surface through a complex interaction of many physical, biological, pneumatic, and hydraulic processes.

This concept was rigorously tested during the past decade under a wide diversity of edaphic, vegetal, and climatic conditions in Wisconsin, Montana, Nevada, and Arizona. Infiltration runs made on hand-imposed microroughness and macroporosity treatments demonstrated that infiltration can be controlled by an order of magnitude immediately and by up to two orders if treatments are maintained for several years. This widening of the control range with time is caused by a number of physical and biological processes which may be active either during the infiltration event or between events, or at both times.

The land imprinter produces soil surface geometries very similar to the hand-imposed surface treatments used in validating the AEI concept. Consequently, the land imprinter is expected to give an infiltration control range similar to that of the hand-imposed treatments.

Land imprinter forming rainwater-irrigated seedbeds in an area infested with creosotebush near Tombstone, Ariz.



Some of the imprint capsules available for the land imprinter.

Unique Functions

Land imprinting is a unique new concept in land tillage. According to the land imprinting concept, the two major tillage functions are mechanical formation of (1) seedbeds having surface geometries and physical properties appropriate for rainwater infiltration control, crop seed germination, and crop stand establishment and (2) surface conditions appropriate for, and leading to, subsequent development of subsurface conditions that are optimal for growth of crop roots.

The first function is performed by the land imprinter, which creates unique rainwater-irrigated seedbeds through the formation of runoff-enhancing and runoff-directing furrows that are interconnected to runoff-ponding and infiltration-enhancing furrows. By this means rainwater is concentrated and infiltrated precisely where grass seeds are placed to insure adequate moisture for seed germination and stand establishment.

The second function is accomplished mainly by biological processes (and resulting physical and hydraulic processes) that are favored by the imprinted surface geometry. The newly established crop stand and the imprinter-created surface mulch interact to heighten the activity of small soil animals. This activity increases surface microroughness and macroporosity and thus water infiltration in accordance with the AEI concept.

Thus, mechanical infiltration control with the land imprinter leads to enhanced infiltration through greatly increased biotic activity. Additionally, this biotic activity and associated physical and hydraulic processes produce the desirable effects of deep soil tillage (including soil loosening, mixing, and aeration) without the development of traffic and tillage pans beneath the loosened tillage layer. Such pans restrict downward movement of crop roots and soil moisture.

Inherent Advantages

The land imprinter has several intrinsic advantages relative to alternative tillage implements. Included in these are the land imprinter's ability to:

- Increase depression storage by forming closed, angular pockets (that can hold up to 2 inches of rainwater) without inverting the soil surface layer and without covering above-ground plant materials.

- Form complex and stable geometric surface configurations by compressing, shearing, mixing, and embossing (essentially in that sequence) the immediate soil surface layer and above-ground plant materials.

- Increase (rather than decrease) effective surface mulch by crushing, chopping, mixing, and partially imbedding above-ground plant materials (thereby concentrating them at the immediate soil surface) while at the same time forming rainwater-irrigated seedbeds.

- Impress and emboss the soil surface with geometric patterns that give better control over rate, route, duration, and microsite of infiltration, runoff, and erosion for the purpose of enhancing seed germination, seedling establishment, crop growth, crop yield, and protection and conservation of soil and water resources.

- Make a smooth-sided, V-shaped furrow for efficient line concentration of forage seeds, soil fines, plant residues, and rainwater through the processes of gravity, wind erosion, splash erosion, splash-off, and runoff.

- Reduce land treatment costs because of the large number of tillage functions performed simultaneously and the relatively low maintenance and labor costs.

- Operate satisfactorily without breakdown and rapid wear on rough, rocky, brush-covered terrain usually considered untillable.

Preliminary Tests

After 18 months of land imprinter testing (including one location in western Texas and 11 in southern Arizona), the following generalizations are apparent if not obvious:

1. The land imprinter is a rugged, simple machine with no apparent design flaws emerging after 200 acres of testing under extreme conditions.

2. The imprinter operates satisfactorily in soils ranging from rocky to clayey and from dry to moist.

3. The imprinter functions, as designed, to concentrate rainwater where seeds are placed.

4. Imprint geometries hold soil and water resources within the imprinted areas, even under intense, long-duration storms.

5. The imprinter successfully established Lehmann lovegrass during a hotter-and-drier-than-normal growing season.

6. Imprint capsules effectively crush and chop above-ground vegetative material to increase the protective soil cover.

7. The land imprinter can roll over shrubs having basal diameters up to 3 inches, or even larger if shrubs are laid down in advance of the imprint roller.

8. Splash erosion provides adequate covering for seeds.

9. Small grains can be successfully planted with the land imprinter without special modifications of the imprint capsule geometry.

10. The land imprinter kills most of the above ground growth of shrubs, mulching and anchoring this material at the same time. This helps conserve water for grass establishment by reducing transpiration and evaporation.

11. The imprinter thins existing grass stands somewhat, but the remaining grass responds rapidly to improved soil moisture conditions after the first good rain.

12. The land imprinter operates satisfactorily on deeply dissected land surfaces strewn with boulders.

Evaluation Plans

The land imprinter is designed to be a versatile no-till implement. Because preliminary tests have been highly successful, plans are being developed for more extensive testing for uses including:

1. Conversion of desert shrublands to grasslands in the southwestern United States and northern Mexico.

2. Reclamation of surface mined lands in southern Wyoming.

3. Revegetation of abandoned farmland to control wind erosion and tumbleweed problems in southern Arizona.

4. Revegetation and interseeding of sagebrush lands of the Great Basin for inhancing the habitat of cattle and wildlife.

5. Revegetation of marginal wheatlands in the Great Plains for wind erosion control and forage production.

6. Interception of drainage from feedlots in Minnesota for point-source pollution control.

7. Pasture renovation in the Great Plains and Corn Belt regions.

8. Conservation seeding and planting of major food and feed crops in the Great Plains and Corn Belt regions.

9. Formation of rainwater-irrigated seedbeds and rootbeds for growing forage shrubs in Israel.

10. Conservation tillage for controlling runoff and erosion from croplands and the control of nonpoint source pollution of surface waters and groundwaters.

Research plans are also being developed to relate successful seed germination and seedling establishment to the physical properties of the microniches formed by the land imprinter. The outcome of such research will be useful in modifying old imprint geometries and designing new ones.

Dryland Farming and Range Equipment in Australia

Charlie Heinrich, *Horwood Bagshaw, Ltd.*

Horwood Bagshaw, Ltd., one of Australia's leading manufacturers of agricultural machinery, has been manufacturing equipment for dryland farming and range rehabilitation for over a century.

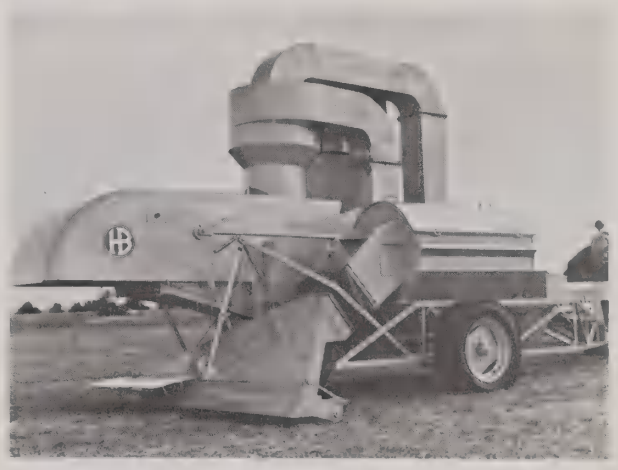
The company has two large manufacturing plants in South Australia and produces a range of products for agriculture and land development, including scrub rakes, wake rakes, and chain slashers; a range of heavy-duty cultivating equipment with stump-jump action up to 9 m wide with folding wings; seed and fertilizing drills up to 5.9 m; sowing width fertilizer spreaders; and a large range of tine harrows hydraulically operated for trash clearance and folding working width up to 14 m.

Horwood Bagshaw, Ltd., also specializes in power takeoff grain combines for cereal crops, sorghum and other seed crops, and a machine of unique design, the Universal Seeds Harvester, using the suction pickup system to harvest pasture plants with prostrate seeding habits.

The company distributes a large range of haymaking and harvesting equipment throughout Australia, New Zealand, and neighboring countries.

The mining and industrial division manufactures a range of specialized mining equipment, including low profile ore loaders, well drilling equipment, and structural steel.

This company's products are exported to over 30 countries, where the equipment is preferred because of its specialized design, strong construction, and reliable performance.



Horwood Bagshaw, Ltd.'s Universal Seeds Harvester with large threshing cylinder.

Case Unimog

Brad L. Buffington, *J I Case*

The Case Model 4/94 Unimog is designed especially for forest firefighting, reforestation, and land clearing. It is equipped with a front-mounted Royer shredder, model 6001-U, and a rear-mounted Pacific pumper 500-gallon fire tank.

The PTO- driven Royer shredder can clear brush and small timber up to 5 inches dbh (diameter breast height) at the rate of up to 3 acres per day. It chips the brush with 38 replaceable cutters mounted on a revolving drum. The peripheral speed of 115 mph is attained by the cutters. The shredder can be removed in less than 15 minutes.

The Pacific pumper has a capacity of 500 gallons and is of the "slip on" design. The tank is fiberglass with six baffle compartments. The electric hose reel has 200 feet of 1-inch booster hose. The Wisconsin air-cooled, 8.9-horsepower auxiliary engine drives a four-stage centrifugal pump 75 to 80 gpm free flow and 35 gpm at 200 psi. The engine package features an automatic shutdown when the tank is emptied to eliminate pump damage.

The Unimog can travel over the road at 46 mph and has off the road, rough-terrain capabilities with extremely good stability characteristics.

Case Unimog designed for forest firefighting reforestation, and land clearing is equipped with 500-gallon Pacific pumper and Royer shredder.

Instrumentation of Disturbed Lands

Ingvard B. Jensen, *Montana State University*

The ever-increasing public awareness of the limited and fragile nature of our environment has led to the development of intensive scientific investigations and resource management improvement programs. These programs depend upon the thorough understanding of the atmospheric and rhizospheric conditions. In order to accomplish this understanding, intensive monitoring on a continuous basis is required.

My involvement with disturbed land rehabilitation for the past 14 years has required the continuous use of environmental monitoring systems. Based upon my experience in this field I will present a brief overview of some of the equipment available, along with some guidelines for its selection and operation. Considering that nearly all projects require unique types of systems, I will not make specific recommendations on equipment types or brand names. My basic objective is to inform you of what is possible with modern automatic data collection systems and to forewarn you of some problems you may encounter.

The standard approach to atmospheric monitoring has been to use a weather bureau approved instrument shelter with maximum and minimum thermometers, a storage type rain and snow gage, and the type A evaporation pan. The frequency and accuracy of data collection were often limited by this type of equipment because of the need for almost constant servicing by personnel.

The increasing demand for intensive monitoring of many environmental factors simultaneously over long periods of time has encouraged the development of more complex monitoring systems. The need to record data from numerous sensors every few minutes on an uninterrupted basis has outdated the past approaches. Even if data could be collected in an adequate manner using the older methods, the labor costs would be prohibitive.

Major advances in the development of electronic components within the past 5 years have enabled the design and construction of relatively inexpensive and efficient systems capable of collecting and recording data as required. The one most significant development in the electronics field has been that of the integrated circuit (IC).

The first electronic data collection systems relied upon the vacuum tube, which was bulky, consumed large amounts of electricity, emitted excessive amounts of heat, and had a short life. Later the transistor was developed, which proved to be a great advance toward a more reliable data collection system. However, not until the IC was developed did economical and reliable systems become a reality.

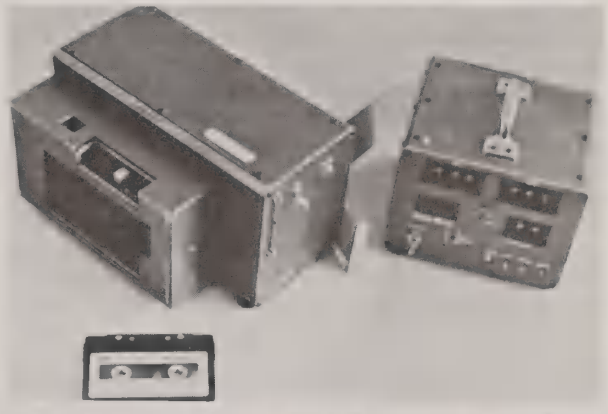
The IC is a small, plastic encapsuled component approximately 8 cm wide by 20 cm long by 8 cm thick that can be rapidly extracted or plugged into a circuit board. Each IC can contain hundreds of microsized transistors, diodes, and resistors that can rapidly perform many operations. The IC uses small amounts of electricity, dissipates virtually no heat, and is reliable. An IC costing less than $5 can accomplish the same task as that of a circuit board constructed of discrete transistors, diodes, and resistors costing more than $100. Instead of requiring a continuous 100-watt or more electrical supply from a powerline the IC can be operated with a flashlight battery for more than a year. This new development has enabled the construction of economically priced, compact, and efficient automatic data collection units.

These compact data collection units have the capacity to record data from a large number of individual sensors at almost any time interval. Using a standard C-90 cassette tape for data storage, 25 channels can be read every 20 minutes and the data stored on the tape for more than a 2-week period. This is equivalent to storing over 25,000 pieces of data on one tape costing less than $5.

Once the data are stored on the tape, how do we retrieve and process them? This question should be intensively studied and answered in detail before deciding upon a specific data system. In general, the recorded tapes are placed in a playback unit designed specifically for the recorded data tapes. The tapes are decoded by the playback unit, and the information is transferred into the main computer storage. Smaller, less-expensive computers are frequently used to complete the above transfer and storage operation. The information is then usually printed on paper or displayed on a monitor to proofread and correct errors. Following proofreading, the data are processed by the computer in accordance with previously developed programs. The scientist has unlimited flexibility in processing the data, running statistical analyses, printing complete tables, and even plotting two dimensional tables. In summarizing the advantages of this system, a scientist can collect tremendous amounts of data, hand manipulate only the small amount requiring correction, and then completely process the information according to his specific needs.

Automatic data recording systems were expensive, bulky, and unreliable when constructed with vacuum tubes (left) or transistors (center). Development of the integrated circuit (right) has enabled the construction of low cost, compact, energy-efficient, reliable systems.

However, like all other tools this system does have limitations which one should be well aware of before purchasing such a system. First and probably most important to a successful system is to insure ahead of time that you will have good compatability of the the data recording system and your data processing computers. Various computers operate with different speeds, data formats, and types of data input.



Integrated circuit has enabled the construction of compact, highly efficient automatic data recording systems.

Another consideration of significant importance is the selection of data sensors which will accomplish the required task and will be compatible with the automatic system. There are virtually hundreds of different types and brands of each kind of sensor. Consequently, it is important that you know exactly how the data are to be used, the requirements of the sensor, and the interfacing requirements for the sensor and data system. Different sensors are designed to output different types of electrical signals. Common output signals are voltage, amperage, resistance, and impulses. However, most data systems now accept only 0 to 1 volt direct current. This means that any sensor not providing such an output must be interfaced into the system by converting an unacceptable signal into the required signal. If not given adequate consideration ahead of time, interfacing can be an expensive problem and can result in reducing system reliability. I recommend, when possible, that the manufacturer of the data collection system supply and interface all the required sensors. As a second choice, plan ahead of time how sensors are to be interfaced into the system.

An important consideration which must be made when installing a system is how will it be repaired within a reasonable time period. If you are not a digital electronics specialist and do not have ready access to trained personnel, you should make arrangements ahead of time for repair services. Do not plan to return a defective system to the manufacturer for repair work unless you have a binding commitment as to how soon the system will be repaired and returned. It is not uncommon to experience a 1- or 2-month delay before the system is returned. Following several bad experiences, I now make every possible effort to have repair work completed locally.

When a system is purchased make sure that you are provided a detailed set of circuit schematics and other material required to completely understand and repair the system. Some manufacturers provide detailed trouble shooting guidelines which have proven to be a great help in isolating problem components. It is also advisable to stock a supply of the components which are difficult to obtain on short notice and are most likely to fail.

Automatic systems are highly complex and must be continually regarded as such. If they are expected to do a good job, they must be maintained frequently. Do not be misled into thinking that because a system can operate for a month without a tape change or battery check that you should leave it unattended for that long. Experience has shown that if possible the system and sensors should be checked at least once per week. The amount of uninterrupted data collected is directly related to how often a system is serviced.

Technicians must be intensively trained on how to maintain the system and how to recognize when there is a malfunction. Because automatic, tape recording data systems do not provide a continuous visual display of the record, it is important that technicians know how to insure that data are being recorded.

Integrated circuits, which are the heart of the modern systems, are extremely sensitive to high voltage. An individual IC placed in a coat pocket can be ruined by small amounts of static electricity. Consequently, one cannot over emphasize the need for isolating these systems from high voltage sources such as lightning and high voltage powerlines. Connections to powerlines for battery charging or for other reasons should be avoided if at all possible. Past experience has shown that systems connected to powerlines, although protected by several lightning protection devices, are frequently damaged. If a system requires large quantities of power, I recommend you use two complete sets of batteries. Connect one set of batteries to the battery charger and the other set to the data system, then rotate the sets of batteries approximately every week or whenever necessary.

In Wyoming, the windy state, we have been using a small 12-volt windcharger for battery charging. The windcharger is located at a lower elevation than the surrounding terrain, thus avoiding lightning strikes. This system has operated very well and has operated continuously for 2 years without a failure. Economical solar panels have also proven to be excellent battery recharging devices. The panels require only occasional cleaning and must be positioned to avoid buildup of snow and particulate matter. Make sure that you install a diode in the charging circuit to prevent battery discharge at night.

In summary, I will say that the new automatic data recording systems are a tremendously useful tool if you realize their limitations. Most important is to plan ahead of time for what you need and make sure the system and peripheral systems can accomplish what is required. You must also plan to provide well-trained technicians to intensively monitor and maintain the systems.

Equipment for Trapping Wild Horses

Texus V. Scofield, *Modoc National Forest, California*

The Devil's Garden Ranger District of the Modoc National Forest consists of approximately 600,000 acres located on the plateau north of Canby and Alturas, Calif., and runs to the Oregon border. Of the 600,000 acres, 236,632 acres are divided among the Emigrant, Pine Spring, Surveyor, Pothole, and Dalton horse territories. The district is responsible for resource management on these territories.

On Dec. 15, 1971, the Wild Horse & Burro Act was signed by President Nixon and designated Public Law 92-195. This act provides for the protection, management, and control of wild, free-roaming horses and burros on the public lands under the jurisdiction of the Secretaries of Agriculture and Interior.

Program Objectives

The objectives of the Modoc National Forest wild horse program are to:

- Manage a horse population in balance with other uses of the national resource lands.
- Provide for the protection and control of horse populations on these national lands in accordance with Public Law 92-195.
- Improve deteriorating habitat and watershed conditions in the horse territories.
- Prevent any further encroachment of horse populations on additional acres of the Modoc National Forest.
- Provide homes for suitable horses of all ages with the public.

During the summer of 1975, a contractor attempted to capture wild horses using a pole-constructed blind trap with short wire wings of approximately 100 yards. No horses were captured under this agreement.

In the fall of 1975 another contractor initiated a capture program using an oblong-shaped blind trap constructed with 6-foot chain link netting, ¼-inch cable, and no. 9 wire.

This trap was located just over a knoll and had up to 1 mile wire wings. The shape of this trap was credited with its success. The horses circled after realizing they were inside but didn't put much pressure on the access gate or opening. All of these traps had to have gates closed manually.

During January 1977, the above contractor successfully bid on a contract for the capture of 100 head of adult animals. At this time ideas were beginning to fly about concerning some method of automatically closing trap gates.

We contacted the Forest Service Missoula Equipment Development Center (MEDC) for some advice on electronic devices and help on constructing a triggering mechanism for tripping the trap gates. Several MEDC employees responded immediately; and early that spring personnally delivered a trigger mechanism that would work off of an electric eye trail counter.

The contractor set up an egg-shaped trail trap constructed with chain netting, cable, and camouflage paint. There was a 20-foot powder river gate at each end. The triggering mechanism was mounted on a tripod and attached to each gate. The electric eye was mounted on a juniper so the beam intercepted the probable route of the target animals. Both gates were set to close as beam was broken. The power source for this setup was three 9-volt batteries.

Problems were encountered. The electric eye was sensitive to dust, wind, leaves, snow, birds, etc., and we would find the gates closed and no horses.

Going back to the drawing board, the contractor came up with a thermal heat sensor manufactured in Portland, Oreg. The power source for this device is a 6-volt, dry cell motorcycle battery. The battery is good for 6 months because it only works when points are activated. Animal body heat is what breaks the circuit. Target distance is up to 140 feet. The thermal heat sensor device was found to be absolutely foolproof. No more checking traps to find gates closed from no apparent reason.

Other pluses include the fact that numerous traps can be installed and operated with the same work force; device can be set at height of target animal; unit could be used in any kind of wild animal trapping operation; before-capture stress to animal is minimized.

Our next drawing board creation was a different type of gate. It is built on the principle of a shutter. With this gate and heat sensor you do not have to have people in positions to scatter horses when close to trap entrance. Concealment both from scent and sight is very important in this capture operation. Width of gate can play a real role in trap success.

Just remember, even with the modern-day devices, you still need to spend time running patterns with your animals and setting up the ground work. We can set up equipment but some local boys need to say where.

A lot of credit goes to Missoula Equipment Development Center for its help and support on this program.

Forest Service Equipment Development Center Activities

Representatives from the two Forest Service Equipment Development Centers presented slide programs on current activities that were not reported elsewhere at the Workshop but were felt to be of interest to Workshop participants. Dick Hallman presented the Missoula Equipment Development Center program and Dan McKenzie the San Dimas Equipment Development Center program. Here is a brief summary of each.

Missoula Equipment Development Center

The Missoula Equipment Development Center is located at Fort Missoula, a military reservation just west of Missoula, Mont. We have about 80 development projects at the Center. For management purposes, these projects are divided into 10 programs. Range Management, which includes our work in mined land rehabilitation, is one of our program areas.

Most of the projects in our Range Program have been or will be covered by the Workgroup chairmen at this meeting. This evening I'd like to briefly discuss a few of the current projects in our Timber Program and specifically the reforestation portion of that program.

ED&T 7086–Instrumentation to Measure Seedling Dormancy: Researchers have found that when electrical impedance through seedling tissue is displayed on a square-wave oscilloscope, changes in the trace can be used to estimate the degree of dormancy. Besides being useful for research, nurserymen use the technique to regulate lifting schedules. The problem is that current equipment is expensive and bulky. Center engineers are attempting to replace the oscilloscope with a small, solid-state instrument that should be much easier to use. Ten of these prototype dormancy meters are being evaluated by plant physiologists in this country and in Canada.

ED&T 2522–Precision Nursery Seeder: To find a seeder that helps nurserymen meet their current needs, especially for planting small seed lots, new commercially available machines, as well as prototype seeders, were evaluated. The Øyjord Seeder, a machine built in Norway was judged best. By working with the Norwegian manufacturer and a firm in Washington State, we will soon have a domestic source for this seeder.

ED&T 2547–Intensive Nursery Culture: In Sweden and in other Scandinavian countries, the bedhouse concept has been used for years to accelerate early seedling growth. We are participating in bedhouse growth studies at three Western tree nurseries to determine if this concept is economically feasible for growing Western conifers. If the experiments indicate it is, Center engineers will then attempt to improve equipment and structures to optimize the concept.

ED&T 2614–Handclippers for Precommercial Thinning: For several years we have looked for handtools for precommercial thinning in rough, mountainous terrain that are safer and more efficient than the power saws now used. By evaluating numerous hand clippers, we found that under normal conditions, the average forest worker can thin as may trees with clippers as with power tools. We are recommending two different sizes of clippers: a smaller model for stems up to 2 inches and a larger one for stems up to 3½ inches.

ED&T 8014–Electronic Fumigation: Undesirable soil pathogens in a nursery bed can contribute to loss of seedling vigor and sometimes cause mortality. Current chemical fumigation methods are effective but costs and toxic build up in the soil are problems. We will be evaluating the use of microwave to sterilize nursery soils. A Texas firm is developing a system that we plan to experiment with this year.

ED&T 2548–Equipment for Processing Small Seed Lots: With the tree improvement program gaining momentum across the country, foresters are looking for equipment better suited for treating small seed lots. This catalog was assembled to help show what equipment is available. In the process of assembling the information, we found that there is a need for a small seed lot dewinger. Plans are now available for this machine.

ED&T 1420–Timber Management Technical Services: Under our Timber Management Technical Services Project, we conducted a survey of all National Forests in 1976 to determine where equipment development technology could be used to help solve timber management problems. In the reforestation and timber stand improvement portion of the survey, the problems associated with cone and seed harvesting led the list by a wide margin. The Center has begun work to try to help solve some of these problems under ED&T 2670—Cone and Seed Harvesting Equipment. The problem can be divided into two parts: collection from tree seed orchards and collection from wildstands.

In the South there are about 13,000 acres of tree seed orchards. Here, loblolly pine is a problem because its cones are persistent and must either be hand picked or the seed must be gathered after it has been released. To tackle the problem of seed collection in tree seed orchards, we worked with private industry to develop and evaluate a vacuum seed pickup machine. These machines will be in operational use in Southern orchards next fall.

Where the orchard floor is too rough for the vacuum pickup technique, plastic netting can be spread throughout the orchard to catch the seed. The netting can be retrieved periodically or left for the entire season. The problem is that when the netting is retrieved, large amounts of needles, branches, and other materials are mixed in with the seed. We are working on the design of a combination retrieval and seed separation system that will be ready for testing next fall.

The big problem remains that of collecting cones or seed in wildstands in mountainous terrain. We hope to start on this problem next fall. In the meantime, we are putting together a slide/tape series that will help field personnel make the most of the techniques now available.

Being able to predict good cone years is one important element of the collection process and although this is not an equipment problem, we are including it in the series to help field personnel learn the cone development process, from the female flower ...and male pollen cone ...to the developing cone ...and finally to the mature cone. Our main purpose, however, is to show what equipment is available and how it should be used.

ED&T 2669–Nursery Equipment Catalog: Nurserymen have long expressed the need for a catalog of equipment that can be used to meet their special needs. In 1976 we finished work on the catalog and have since distributed hundreds of copies to Federal, State, and private nurserymen. To meet the same kind of need in other areas of resource management, we are working on a reforestation and timber stand improvement handbook, a trail maintenance equipment handbook, a greenhouse equipment catalog, and a range equipment handbook. The range equipment handbook will be a revision of the 1965 version of the *Range Seeding Equipment Handbook.*

To finish this presentation, let me mention a few of our recent reports that may be of interest to you: The first is a report that describes current methods and equipment available for mechanically treating browse. Another recent report deals with techniques and materials available for correcting vertical fish barriers. Last year this Workshop funded the Center to finish work on a handbook of equipment for reclaiming strip mined land. You can get a copy of these reports as well as other Center reports by filling out the order blank that we have on hand at this meeting.

In addition, we have brought copies of last year's Workshop report and copies of the history of the Range Seeding Equipment Committee. If we run out these last two reports you can also order them on the order blank. Thank you.

San Dimas Equipment Development Center

In fire management, the San Dimas Center, San Dimas, Calif., has equipped ground tankers (fire trucks) with both liquid concentrate fire retardant and dry powder fire retardant. Also, SDEDC is working on long-term fire retardants for critical areas such as roads or railroad rights of way. On the opposite end of the fire retardant program, wetting agents are also being evaluated for effectiveness in firefighting.

The Center is actively working on the problem of disposing of forest residues on steep slopes. Two designs of small-man, portable cable winching systems (concentrators) have been designed that use 500 feet of 3/16-inch cable. They are now undergoing field tests. One unit is a low-cost, single-drum system requiring the cable to be manually payed out; the second unit is a remotely controlled double-drum system.

In Forest Roads and Trails, we are developing ways to improve the efficiency of the Forest Service transportation system. SDEDC is investigating problems encountered with rock rakes and grader cutting edges. We are working with Forest personnel and manufacturers to modify and improve the efficiency and performance of this equipment.

SDEDC has undertaken a large, comprehensive study of road deterioration and its relationship to types, sizes, and weights of vehicles using the road. The study is concentrating on gravel roads to determine the rate of wear from various vehicles under differing loads. The study also will incorporate data from other studies, such as the asphalt-stabilized sand road on the Chippewa National Forest, Minnesota. Sections of this road were designed to fail at predicted time intervals.

In the area of recreation, the Center's environmental engineer has been working with a plastics firm to develop a more durable, longer-lasting vault toilet riser stand than the current stainless steel riser. Stainless steel is easy to dent and the seat loosens easily. The new cross-linked polyethylene riser will withstand much more abuse than the stainless steel unit; kicking it, throwing rocks at it, or hitting it with a sledge hammer will not affect the new riser. The cost will be approximately $38 f.o.b. California, a cost 25 percent below the stainless steel riser. A choice of colors will also be available. The Forest Service now has approximately 40,000 vault toilet risers in service costing about $50 each. This is a $2 million inventory and does not include those owned by the Bureau of Land Management, Corps of Engineers, National Park Service, and other Government agencies.

The Equipment Development Center recently received a delivery of 1,000-gallon, cross-linked polyethylene containers that will undergo evaluation as underground vault toilet tanks.

The Center has investigated portable field housing and several promising units were located. One is made of fiberglass sections and can be erected with snap clamps by a crew of three in only 45 minutes. Another manufacturer can supply a barracks-type mobile unit to accommodate up to eight people.

SDEDC, through its Air Technical Services Project, assisted the Los Padres National Forest, California in reseeding 156,000 acres of last summer's Marble Cone Fire (174,000-acre fire) with common rye to prevent severe mud slides during runoff from expected winter rains. Two C119 aircraft completed the job in 10 days, dispensing almost 1 million pounds of seed. This is about 35 seeds per square foot or 6 pounds per acre. Each aircraft carried 10,000 to 12,000 pounds of seed and made four to six sorties a day.

One reason the job was completed so quickly was because the planes flew a race track pattern, which minimized nonseeding turn around time. A ½-mile radius turn at each end of the race track pattern was the usual rule with some straight legs up to 16 miles long. This race track pattern requires four flag crews per aircraft or eight flagmen for each race track operation. These flagmen were delivered to the flag positions each morning by helicopter and picked up each evening. It was also required at times during the day to move the flagmen by helicopter to new positions.

One of the most effective items used by the flagmen was the World War II signaling square mirror with a superimposed image sighting device. The pilots found they could spot the mirror flash 6 to 8 miles out, and by homing on the flash, could greatly improve the accuracy of their grid flight pattern.

A vendor demonstrated to SDEDC a device to safely dispense the standard low cost fusee (cost per fusee about 30¢) from a helicopter or fixed-wing aircraft for use in backfiring. The standard fusee is fitted with a special cap (cost estimated to be 2¢) that has a wire across the end. As the fusees are released and slide through a tube, two electrodes rub against the special cap with the wire, heating the wire and igniting the fusee as it falls free of the dispenser. This dispenser appears to be a safe, effective way of dispensing low cost fusees from aircraft. The current unit is equipped with a rotating cylinder that holds six fusees. The dispenser could be hand fed or fed automatically by a magazine that would hold a large number of fusees.

Revegetation Equipment in Germany and the Soviet Union

Don Calhoun, *Bureau of Land Management*

Today I would like to report on a most interesting trip to the Soviet Union and West Germany as it relates to this group.

By way of background, an agreement between the U.S. and U.S.S.R. was signed May 23, 1972, that provided for the exchange of technical information in the field of environmental protection. Some 135 subject areas are covered by this agreement, and about a year ago a new project was initiated entitled Reclamation and Revegetation of Surface Mined or Otherwise Disturbed Land. I was fortunate enough to be named project leader on the U.S. side, along with four other Americans as members of the working group. Two groups of Russian scientists have visited the U.S., seeing areas in North Dakota, Montana, Wyoming, Colorado, Alaska, Kentucky, West Virginia, and Pennsylvania. The U.S. working group went to Russia in July 1977 and visited mining areas in Estonia, Ukraine, Georgia, as well as the main part of Russia. These have been productive exchanges involving literature, photographs, a dictionary, a glossary, plant materials, and research documents. And this is only the beginning. There is much more that can be done which will be mutually beneficial to the two countries.

The types of mining areas we saw included oil shale, coal, manganese, sand and gravel, and fire clay. We were also shown areas that are being transformed from woodland or grazing areas into farming. It must be kept in mind that their primary interest in mined land reclamation is to return these areas to farm lands. We are also interested in their reclamation work being done in the colder, drier regions, but as yet we have not seen this. We are also exploring the idea of exchanging junior scientists for periods of 2 months or so for intensive study of research activities at specific locations.

As an overall impression of their reclamation work, I would say that their research programs, technology, and general approach would be superior to ours. Of course, several qualifiers have to be added here: this would apply only to the areas we saw; we were probably shown their best areas; and in their most productive zones. We did not see much mining or reclamation equipment in actual operation; however, it would appear that their *equipment* would be quite inferior to ours, that is trucks, draglines, dozers, and shovels.

Some of the equipment we saw seemed quite efficient in terms of handling material, such as bucket

wheel excavators, conveyor systems, and overhead tram systems, even though these machines were greatly inferior to those seen in West Germany. We also saw some unique and innovative equipment such as hedge trimmer-like machines used to harvest tea, and a monorail machine used to haul fertilizer and other supplies up steep slopes, and also to haul harvested crops down these steep slopes. This machine employed a chain saw-type engine for power and could haul 1,500 pounds up or down a 45-degree slope on a monorail, and it operates almost automatically.

Another innovation that was noticed involved the use of prefabricated concrete slabs for road beds. As you might imagine these roads are not too smooth, but they are usable in any weather or soil conditions, and they are movable as necessary. These slabs are fabricated at centralized points and stored at a mine where they will be needed. Their size is about 8 feet square and there are hooks on two sides by which they can be lifted and placed in position.

The trucks and dozers we saw were small and inefficient. They all looked alike and did not appear to be very powerful. It appears that they design one machine model, and this is produced without change for a number of years. This of course has some advantages as well as disadvantages. I would say that the appearance of these machines would compare to those found in the U.S. in the 1930's. We also saw some machines that are used for irrigation. These involve a tracked vehicle like a dozer on which is mounted 150-foot booms on each side. Water is pumped out of a ditch and out through the booms equipped with nozzles. In this way, 300-foot strips can be irrigated. This machine did appear inefficient from the standpoint of manpower since about four men are required to keep it in operation.

Another equipment item that we noticed and rode on is the hydrofoil. It has nothing to do with reclamation but it is very interesting. The boat contains two powerful diesel engines, and will carry about 150 people at speeds of 40 to 50 mph. As the boat picks up speed, it gradually raises up out of the water on fin-like attachments until the main structure of the boat is above the water. This makes a smooth ride even in rough water and at high speed. Apparently this is the only place where this type of boat is manufactured, and the U.S. has bought some, and other countries have also.

Please keep in mind that equipment was not our primary concern on this trip, so this information results from one person's casual observations and may not be accurate or complete. The Russians do have a lot of interest in the development of equipment so there may be an opportunity to exchange some ideas and information of this type with them. Would VREW be interested in such an exchange with the Soviet Union?

After spending 16 days in Russia, it was our great pleasure to be able to visit the Rheinbraun coal mining area near Cologne, West Germany. What we saw there in a very brief visit was enough to absolutely boggle one's mind. As an overall impression of their mining and reclamation work, I would say they are probably 50 years ahead of us in every way. This has to be the world's leader in terms of how to do things right, and it's a shame that we can't learn from them and adopt some of their ways of doing this important work.

Their planning procedures and problems are quite similar to ours, but their solutions are much better. The main difference being that planning is initiated on a large mining area (100-year $\pm$ operation) (over 20,000 acres) that is densely populated and contains prime farming areas. After all the planning agonies are completed, public involvement is completed, intense governmental review is completed (73 agencies), and the responsible official finally stamps "approved" on the plan, it becomes a permanent, binding national commitment to the operation. The mining and reclamation work is supervised by *one* government agency, and the mining company is required to comply precisely with the provisions of these plans.

With respect to their equipment, it was also very impressive. One of the surface mines we saw was 25 square kilometers in size. The total depth was in excess of 1,200 feet (including 300 feet of coal), and we were told that within 3 years they will be operating to depths of 1,700 feet. Draglines, shovels, trucks, and scrapers were not in use. They were using bucket wheel excavators, conveyor belt systems, and stackers to handle all the material. The latest model bucket wheel excavators have a capacity of 240,000 cubic yards per day.

Conveyor belts with widths from 6 feet to 10 feet are numerous. They all lead to a central point like a railroad station where the various materials are dispatched by computer to various locations in the mine and returned to the same relative location in the overburden profile from which they came. The vast conveyor belts are moved quite readily and quickly by tracked vehicles like dozers travelling alongside the conveyors at 4 to 5 mph and sliding them about 3 feet at a time. The efficiency by which the topsoil, overburden, and coal are segregated, removed, the areas reshaped, and made ready for revegetation is really amazing.

The final phase of the material handling is the replacement of topsoil or loess. Thirty percent of the reclaimed areas are returned to forests, and the remainder are returned to farm lands. If the area is to be revegetated as a forest, 3 feet of loess is replaced; if it is to be farm land, 6 feet of loess is replaced. These requirements are irrespective of what was there before. One area we were shown was being resurfaced with loess that was hauled in by train 25 kilometers. They use two methods of final placement of the loess: (1) the dry method by conveyor belt and stacker; (2) the wet method, which involves pumping the material as a

slurry mixed with water on a 1:1 basis. In either case, the material is placed with precision to the required depth. We were told that the slurry method was cheapest.

Being somewhat familiar with the lignite deposits, climate, and soil conditions in North Dakota, I asked one of their mining engineers who had traveled extensively in the U.S., if the German type of system could be used in North Dakota, and without hesitation he replied, "absolutely!"

I am sure that many changes would have to be made if that type of system were to be used in America, but many of the ideas and concepts could be used and someday they will be. And the sooner the better.

Applications of Large-scale 35mm Color and Color Infrared Aerial Photography to Analysis of Fish and Wildlife Resources on Disturbed Lands

Dr. Merle P. Meyer, *University of Minnesota, St. Paul*
(Presented by Don C. Mellgren, Fish and Wildlife Service)

Abstract

A 35mm, motordrive aerial camera system using a special (exterior) small-aircraft sidemount was tested over a representative sample of abandoned surface mine sites in western Virginia. A number of film/filter/scale/altitude configurations and photo interpretation techniques were investigated to determine the technique's applicability to gather surface data (for example, vegetation, soil, water, etc.) necessary for planning surface reclamation and ultimate surface management. A system of flight planning, overflight technique, photo preparation, interpretation, and mapping is described. Although the system's potential capabilities for surface feature detection and assessment were reasonably well defined, its applicability in a practical, production level sense is not possible at this time due to the absence of a clear definition of basic data needs at the actual surface management level.

Introduction

U.S. Fish and Wildlife Service resource managers are increasingly faced with the difficult tasks of: (1) successfully meeting the growing demand for added and improved resource survey data, and (2) solving the expanding number of difficult scientific and social problems associated with data accumulation while, simultaneously, operating at fixed or reduced staffing and operational funding levels. Consequently, it is obvious that effective completion of these tasks can probably be accomplished only by increasing the capabilities of personnel now in the field.

Because of the critical energy situation in the United States, coal mining operations within the Appalachian Region are being resumed on many previously abandoned mine lands and expanded to include new lands due to employment of more efficient equipment, better extraction techniques, and demands for coal. As a result, the U.S. Fish and Wildlife Service has a need for a resource survey system capable of increasing ground personnel capabilities by aiding them in collection of sound technical data, the formulation of reclamation and rehabilitation prescriptions, and evaluation of applied treatments and monitoring of mining operations. Considering the intrinsic difficulties in obtaining on-site data from this area (that is, rugged terrain, dense adjacent vegetation, and limited access) it was speculated that a remote sensing technique could be effectively employed to complement field operations in collecting and maintaining an accurate resource survey data base over large geographical areas. The type and quality of the information obtained from two low altitude remote sensing studies applied to rangeland analysis in the Western United States indicate such techniques have definite potential for abandoned surface mine land applications. Consequently, this study was designed to evaluate the operational efficiency of a low-altitude, small-format camera system and determine the quality and quantity of detectable resource information, as applied to analysis of disturbed mine lands in the Appalachian Region.

Project Objectives

- Assess the capabilities of various small-format aerial camera systems (camera/film/filter/time/scale/lens configurations) and select the parameters for a best possible combination.

- Ascertain the range of surface features subject to reliable detection and assessment with a small-format aerial camera remote sensing system.

- Design a practical system of sequential aerial photographic monitoring (aerial photography, processing, image interpretation, and mapping) of significant conditions and changes in soils, vegetation, and other features over time as they relate to treatment and management of abandoned mine land study sites.

Project Area Location, Description

The study area includes 17 abandoned mine land sites located within three southwestern Virginia counties adjacent to the Virginia-Kentucky border: Wise, Dickenson, and Buchanan. These are typical surface mines (that is, poor ground access, steep hillsides, scant human habitation, and adjacent to dense overstory and understory vegetation).

Discussion

In general, the operational efficiency and practicality of the small-format 35mm camera system as applied to this study, including flight planning and flight operations, proved to be quite successful.

Those interested in obtaining more details on data collection, analysis, project design, or photographic interpretation can obtain a copy of Research Report 77-3 by writing to Group Leader, Eastern Energy and Land Use Group, Fish and Wildlife Service, Brackett House, Harpers Ferry, W. Va. 25425.

Coal Mine Reclamation in Colorado

Kent A. Crofts, *Energy Fuels Corp.*

Past Reclamation Practices

Compared to other sections subject to strip mining in the West, Colorado has had a longer period of active reclamation than many other areas. Although the first reclamation laws affecting the area were not passed until 1969, an active reclamation program was instigated as early as 1965. From 1965 until the program was discontinued in 1968, a total of 1,355 acres was seeded under this voluntary program between the Colorado Department of Natural Resources and the three operating coal mines. During this period, a total of 13 grass species were aerial broadcast onto relatively ungraded spoil ridges. Some 32 species of trees and shrubs produced at the Colorado State Forest Service Nursery were also transplanted under this program.

Success of these plantings has been reported in various scientific publications. Among the conclusions reached during these studies was that, due to ease of establishment, alfalfa had almost been abused as a revegetation species. Dominance of this species had caused the ranchers owning the surface rights to spray the revegetated areas on an annual basis to protect the grazing livestock from bloat. Total forage production on the revegetated spoils often equaled that found on undisturbed sites, but specie diversity was so low that the area was still unused by the surrounding wildlife.

Two important findings of these studies were: (1) an adapted nonbloating, nitrogen-fixing legume was needed to replenish soil nitrogen lost as a result of burying the topsoil; (2) restoring the browse component necessary to provide the food and cover requirements of wildlife had scarcely been addressed in previous reclamation programs.

Passage of subsequent reclamation laws by the State of Colorado in 1973 and 1976, the U.S. Department of the Interior in 1976, and the Federal Surface Mining Control and Reclamation Act of 1977 have greatly added to the requirements placed upon industry regarding reclamation. Although many of these regulations are ecologically sound and will ultimately enhance the overall reclamation, a few are both technologically and ecologically without foundation.

Among the practices employed in mine land reclamation, the majority of proven techniques have resulted solely from the efforts of the Range Seeding Equipment Committee. Several newer ideas, yet to be adapted to a variety of mining conditions, are being evaluated by the Vegetative Rehabilitation and Equipment Workshop. Certainly, the efforts of this Committee help to fill a void touched by no other group.

A careful analysis of the current research effort in the field of equipment development adapted to handle the particular problems of strip mined land reclamation indicates that, at least in a historical context, too little attention is being paid to the development of specialized equipment. To be specific, a review of projects described in the booklet, *History–Range Seeding Equipment Committee, 1946-1973*, indicates that from 1963 to 1973, a total of 10 projects were initiated; from 1953 to 1963, a total of 35 projects were initiated; and from 1946 to 1953, a total of 18 projects were initiated.

The interest today certainly is not oriented strictly toward range improvement as was this Committee in its earlier years. It must also be realized that the services of this group are needed more today than ever

before. The impetus created by energy development in the West alone has created a research corps many orders of magnitude greater than that employed during the range improvement days of the forties and fifties. In short, the efforts being directed toward development of specialized equipment in the energy era of the 1970's appear not to be receiving their lion's share of the research monies being spent by the Federal Government.

As a representative of the largest coal mining company operation in the State of Colorado, I appreciate the opportunity extended to my company and the coal industry of northwest Colorado to address this group and explain some of our reclamation practices and ideas concerning rehabilitation equipment. As Dick Hodder mentioned in his talk before this Workshop 2 years ago in Omaha, a formal literature review will not produce the necessary answers or solutions to mine stabilization problems. Those people at the mine site who encounter actual problems seldom have time to write about them in a formal manner. Therefore, the best answer is to go into the pits, observe, and discuss problems and solutions with those who are actually doing something about them. In that light, I thank Don Calhoun for this invitation.

Current Reclamation Practices

Leveling spoil ridges, topsoiling, and revegetation have been required by Colorado law since July of 1976. Energy Fuels has the oldest leveled, topsoiled, and reseeded site in the State of Colorado. Application was made this winter for a final bond release on two such areas. On both areas, we were able to equal predisturbance vegetative cover and production in only 3 years. Since 1977 was the driest year in the previous 50, and 1976 the driest year in the previous 10 years, there is no doubt that these seeded stands have reached an equilibrium between the biotic and abiotic components of the environment.

All seeding is done with a rangeland drill into a prepared seedbed. Some 24 grasses, forbs, and shrubs are included in the mixture. All sites are contour furrowed following seeding.

Revegetation Equipment

To date, most of our revegetation work has been done with farm tractors, standard discs for discing, and an improved rangeland drill. In addition to these standard pieces of equipment, experimental work has been done with the Hodder Gouger and Vermeer Tree Spade. Both of these items were studied by EMIRA personnel of the BLM with the cooperation of Energy Fuels. Results are still inconclusive as to the effectiveness of the gouger at sites on our mines.

Evaluation of the Vermeer Tree Spade operating at the Energy Mine and Edna Mine have produced the following results:

% survival, fall 1977[1]

Species	Edna Mine No. planted fall '75	Energy Mine No. planted spring '76
Aspen	67	63
Chokecherry	19	38
Wildrose	91	—
Oak	33	13
Snowberry	100	100
Serviceberry	86	50
Sagebrush	75	—
Average	61%	53%

It was reported that no more than eight transplants per day could be transplanted using this system. Considerable difficulty was also reported in digging the receiving holes on strip mined land having less than 2 feet of topsoil. On some sites, upwards of 40 minutes was spent digging the receiving holes. As reported in the Forest Service Missoula Equipment Development Center (MEDC) report on this project (*Evaluation of the Vermeer Model TS-44A Tree Spade for Transplanting Trees on Surface Mined Land,* no. 7642 2205, Febr. 1976), considerable modifications were needed before this system could become a reality.

Through the design of a self-contained, rubber-tired, front-end loader and tree spade combination, pulling a trailer capable of holding 8 trees, personnel of MEDC were able to increase production rates up to 24 trees per day over a 2-mile haul.

Energy Fuels Corp. has utilized a large rubber-tired front-end loader for reclamation transplanting the past 3 years. Plantings of aspen and serviceberry made during the winter months have demonstrated exceptionally high survival rates using this system. This past year, transplanting has begun in May and continued until late January when snow depths of over 2 feet forced us to discontinue planting operations. There are several advantages to utilizing this particular piece of equipment. Most importantly, there is not a mining operation in existence without one. Since reclamation is the responsibility of mining companies and will be done by mining equipment, it is only logical to expect that revegetation, too, should be geared to what can be done with on-site mining equipment. A comparison of the MEDC tree spade with our experience over the past 8 months is shown in table 1.

[1]Data from Rich Atkinson, BLM, EMIRA Coordinator, Craig, Colo.

Table 1.—*Cost comparison between front-end loader and tree spade for tree transplanting*

	Front-end loader (12 cu yd capacity)	*Vermeer tree spade*[1]	
Acquisition costs	Available at any mine site	Loader-Tree Spade	$51,000
		Trailer	$12,000
		Pickup	$ 7,000
			$70,000
Season of operations	8 months	4-5 months	
Number of operators	1	3	
Operating costs/day			
Operators	$104	$312	
Equipment	$443	$ 68	
Totals	$547	$380	
Production rates/day			
Number trips	30 (at 0.7 miles)	24 (at 2 miles)	
Area	1,500 sq ft	170 sq ft	
Cost/sq ft	$0.37	$2.24	

[1]Information from Bob Knudson, MEDC.

In summary, a standard 12 cubic yard front-end loader can operate over a much longer period of time, requires only one operator, costs slightly more to operate per day but moves 8.8 times more material at 17 percent of the per unit cost as does a modified tree spade.

Anyone familiar with front-end loaders will soon realize that they are not designed to transplant trees. With only a few single modifications, it is quite reasonable to assume the capacity of the bucket to haul trees can easily be modified to double its present hauling capacity.

Based on the present operating rates, costs per tree using the tree spade are $15.80 per tree. Assuming that a 50 square foot pad of aspen seedlings with 6 trees per pad, the cost per tree averages only $3.04. Through increasing the capacity of the loader by only 50 percent, the cost per tree is only $2.02. Realizing that container-grown seedlings commonly sell at $2.50 per plant, one can visualize the potential impact such a tree transplanter would have on reclamation costs.

Equipment Development & Test Funding

Planning and Budgeting Procedure

For many years the "Range Reseeding Committee" was an informal group, meeting each year to exchange information on work of mutual interst and to develop project proposals for work to be done by Equipment Development Centers or field units. The proposals were written, estimated for cost, and finalized "on the spot." Informal but it seemed to work!

Today there are demands being placed on us to plan in detail 2 years in advance, and in general 5 to 10 years ahead. This does take away some of the informality of the operation and dictates the need for a more organized approach to the preparation and submittal of project proposals. Figure 1 shows a plan by which we can meet our budgeting dates. It provides a mechanism whereby the Equipment Development Centers can stay with the budget process of the Forest Service.

The other aspect of our planning procedure is a more uniform format for project proposals. Figure 2 is a suggested guideline for proposals. Following this guide will help all concerned in preparing and reviewing proposals. It should make the flow of information more efficient and provide a much better story for those who must analyze needs, prepare programs, and assign priorities.

We hope that everyone associated with the Vegetative Rehabilitation and Equipment Workshop will cooperate in this more formal approach. It should be an aid to everyone. If any questions arise or there is a need for help in this process, call the Centers or the Washington Office.

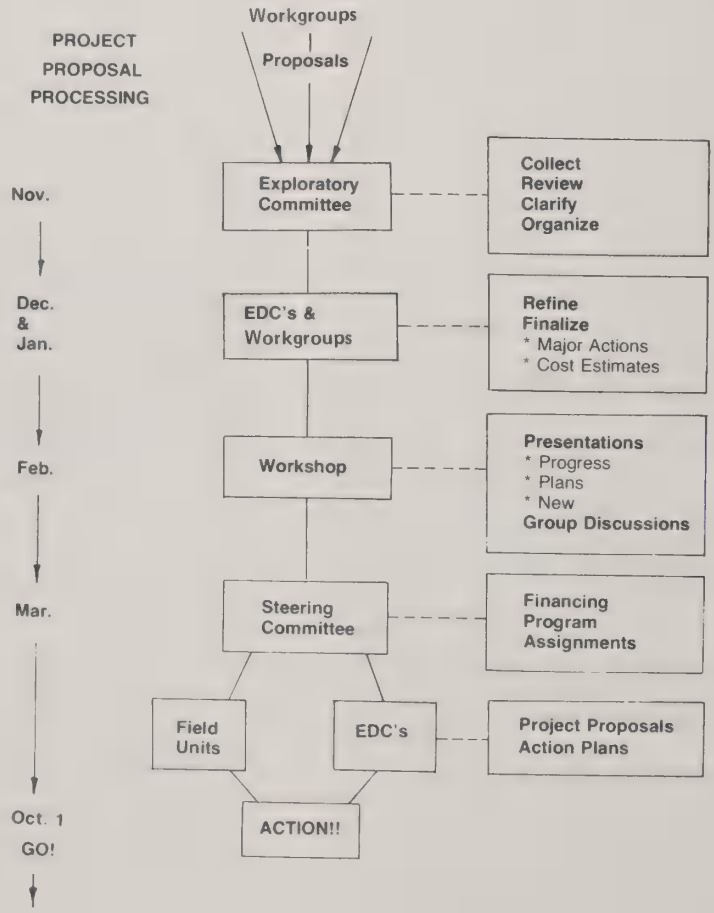


Figure 1. – Project proposal processing.

(PROJECT PROPOSAL FORMAT)

EQUIPMENT DEVELOPMENT AND TEST PROJECT PROPOSAL FOR FY ____

ED&T Project No. (Leave Blank)
Date _____
Primary Interest: _____

_____
(TITLE)

- *(The title should be brief and indicative of project objectives.)*

PROBLEM STATEMENT AND OVERALL OBJECTIVES

- *(State the problem and describe how the work is currently being done. Tell what equipment, materials, or methods are used, and why change or improvement is needed. Show significant advantages and potential savings, such as: increased production or efficiency, property or human hazard reduction, reduced maintenance, and public demand or reaction.)*

- *(State the overall objectives. What is to be accomplished or what is to be achieved by this project?)*

- *(Include amendments to the problem statement and overall objectives, if necessary (for completion by the Development Centers for applicable continuing projects only). The statements of the original problem and objectives should not be changed. If there is a change in emphasis, add revised problem statements and objectives here.)*

SPECIFIC REQUIREMENTS

- *(Distinguish between minimum requirements and those which are desired but not essential. Describe features required or specify performance characteristics. Where more information will be needed but cannot be furnished, list items that should be explored.)*

PRIOR DEVELOPMENT

- *(Briefly describe work already completed or underway which is related to this project. On new projects, this work will generally have been done by other persons or organizations or under other equipment development projects. For a continuing project, tell when it started and briefly state major accomplishments, and actions planned for completion in the current fiscal year. Reference the overall project time frame and total cost estimate if previously made and if applicable, prior reports and publications.)*

PROJECT ORIGIN

- *(Show the name, organization, etc. of persons originating the project and preparing the project proposal.)*

Figure 2. – Format for project proposal.

FY 1978 PROGRAM

ED&T No.	Project Title	Funding
	Missoula	
1450	Technical Services	$ 15,000
1454	Technical Services (EMRIA)	7,800[1]
2624	Wildland Aerial Herbicide Application	15,000
2627	Aerial Burning Equipment for Plant Control	3,000
2629	Soil Conditioner	43,800[1]
2630	Transplanter	43,200[1]
7083	Information Workgroup Support	9,000
8018	Plastic Pipe Fusion Equipment	11,200
8022	Range Equipment Handbook	14,400
8041	Basin Blade	6,300[1]
8042	Dryland Plug Planter	22,500[1]
8046	Dryland Sodder	20,100[1]
	Missoula Total	**$211,300**
	San Dimas	
1421	Technical Services	$16,000
2532	Interseeder for Rocky and Brushy Areas	10,000
2623	Backpack Seed Collector	18,000
2683	Slope Revegetation Equipment	7,000[2]
	San Dimas Total	**$51,000**

[1]BLM-EMRIA funding.
[2]Multifunded with Forest Service Engineering Staff; project total, $75,000.

FY 1979 PROGRAM

ED&T No.	Project Title	Funding
	Missoula	
1450	Technical Services	$ 16,000
1454	Technical Services (EMRIA)	9,000[1]
7083	Information Workgroup Support	9,000
8022	Range Equipment Handbook	11,100
8041	Basin Blade	41,400[1]
8042	Dryland Plug Planter	80,000[1]
8044	Modified Front-End Loader	52,000[1]
8046	Dryland Sodder	69,000[1]
9119	Mined Land Water Test Equipment	12,000[1]
9120	Sprigger for Native Shrubs	11,600[1]
	Missoula Total	**$311,100**
	San Dimas	
1421	Technical Services	$ 16,000
2532	Interseeder for Rocky and Brushy Areas	10,000
2623	Lightweight Seed Collectors	24,900
2625	Punch Seeder Development	25,000[2]
2683	Slope Revegetation Equipment	-0-[3]
	San Dimas Total	**$ 75,900**
	Total Workshop Program	**$387,000**

[1]BLM-EMRIA funding.
[2]Science and Education Administration (SEA) funding (tentative).
[3]Multifunded with Forest Service Engineering Staff; Workshop FY 1979 participation uncertain at time of printing.

FY 1979 FINANCIAL PLAN

Fund Source	Missoula	San Dimas	Totals
BLM—Regular	$ 11,000	$10,000	$ 21,000
BLM—EMRIA	275,000	-0-	275,000
BIA	-0-	5,000	5,000
FS—Range	25,100	30,900	56,000
FWS	-0-	5,000	5,000
SEA	-0-	25,000	25,000[1]
Totals	**$311,100**	**$75,900**	**$387,000**

[1]Science and Education Administration (SEA) funding (tentative).

Agenda

Sunday — Feb. 5

9:00 a.m. **Welcome** ..... Vern Thompson

Morning Discussion Leader ..... Bill Currier

Early Beginnings ..... W.R. Chapline

Workgroup Reports
- Information ..... Ray Dalen
- Seeding and Planting ..... Dick Eckert
- Arid Land Seeder ..... Carlton H. Herbel
- Plant Materials ..... Gil Lovell
- Seed Harvester ..... A. Perry Plummer
- Steep Slope Stabilization ..... Lou Spink
- Disturbed Land Reclamation
  - Eastern "Sub" Group ..... Willis Vogel
  - Western "Sub" Group ..... Don Calhoun
- Thermal Plant Control ..... Bill Davis
- Chemical Plant Control ..... Ray Dalen
- Technician Standards ..... Don Mellgren
- Equipment Parts Facilities ..... Frank Winer

11:30 a.m. **Lunch**

Afternoon Session Discussion Leader ..... Mike Cwik

1:00 p.m. **Workgroup Reports** (continued)

3:00 p.m. **Break**

3:20 p.m. **Papers**
- Land Imprinting ..... Gary Frasier
- Seeding Equipment ..... Mickey Taylor
- Dryland Farm and Range Equipment in Australia ..... Charlie Heinrich
- Case Unimog ..... Brad L. Buffington
- Instrumentation of Disturbed Lands ..... Ingvard B. Jensen

5:00 p.m. **Dinner**

7:30 p.m. **Evening Session**

Papers (continued)
- Equipment for Trapping Wild Horses ... Texus V. Schofield
- Forest Service Equipment Development Center Activities ..... Dick Hallman & Dan McKenzie
- Equipment Development in SEAM .... Bland Z. Richardson
- Affiliation with Other Land Reclamation Associations ..... Don Mellgren

Monday — Feb. 6

Discussion Leader ..... Don Calhoun

8:00 a.m. **Papers** (continued)

EMRIA Program ..... Bob Delk
Research in Mining Equipment ..... Tom Martin
Revegetation Equipment in Germany and the Soviet Union ..... Don Calhoun
Practical Application of VREW Equipment ..... West Boettger

9:30 a.m. **Break**

10:00 a.m. **Papers** (continued)

Aerial Photography for Resource Analysis ..... Merle P. Meyer
Environmental Problems on Eastern Ecosystems ..... Edgar Pash
Coal Mine Reclamation in Colorado ..... Kent A. Crofts
Arid Land Equipment ..... Walter Gould

11:50 a.m. **Wrap-Up** ..... Farnum Burbank

12:00 noon **Meeting Adjourned**

Range Publications and Drawings

Below are titles of reports on a variety of range rehabilitation topics, as well as a list of range equipment fabrication drawings. These materials have been produced by the Forest Service Equipment Development Centers at Missoula (MEDC) and San Dimas (SDEDC) and may be of interest to workshop members. Single copies of the reports and drawings are available without charge by writing to the appropriate Center:

Forest Service, USDA
Equipment Development Center
Bldg. 1, Fort Missoula
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The list of publications includes *Equip Tips,* concise reports dealing with new equipment, new uses for equipment, and similar topics; *Equipment Development & Test (ED&T) Reports,* documenting major development studies; *Project Records,* describing the technical details of development work, including procedures, results, conclusions, and recommendations; a number of special reports, ASAE papers, and service manuals are listed under "Other Reports."

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Incendiary Grenade Dispenser, no. 522

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